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ABSTRACT

This study of negotiation processes between users and librarians in typical reference situations describes association patterns and search procedures in the information transfer process in terms of theoretical approaches, design, analysis, and findings. The thinking-aloud technique of cognitive psychology was adopted to the project, which involved exploratory recordings of communication and information searching, training 20 librarians and seven users in the technique, recording search processes of 13 librarians, and recording the communication and search procedures between three librarians and five users. Transcribing the recordings into protocols (text) included noting pauses, behavioral remarks, and materials used. Microanalysis of the protocols identified the relations between activities, thought processes, and information perceived by the subject during the problem solving process, while macroanalysis identified general problems in the search. Findings identify three basic mental attitudes which determine the nature of searches: open, fixed, and semi-fixed. Influence of knowledge structures on question negotiation processes and implications of the findings are also discussed. Eleven figures, four tables, and 67 sources are provided. (REF)

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USER-LIBRARIAN NEGOTIATIONS AND INFORMATION SEARCH PROCEDURES IN PUBLIC LIBRARIES: ANALYSIS OF VERBAL PROTOCOLS. FINAL RESEARCH REPORT

by

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1980
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FOREWORD

The objectives of the present report are to describe hypotheses, experimental situations and design, analysing methodology and findings as well as to give some consideration to theoretical approaches concerning the user-librarian information transfer process.

The report describes a project which has taken place in the years 1976-1979 concurrently with the training of students in information retrieval on the Royal School of Librarianship, Copenhagen.

Preliminary considerations and findings have been reported at the SIRE conference, Copenhagen 1977 (1) and at the IRFIS 3 conference, Oslo 1979 (2).

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ABSTRACT

The objectives of the present report are to describe hypotheses, experimental situations and design, analysing methodology and findings as well as to give some consideration to theoretical approaches concerning the user-librarian information transfer process.

The theoretical approaches adopted in this study are based on the cognitive viewpoint which refers to developments in cognitive psychology artificial intelligence, epistemology and the empirical research on knowledge acquisition that have crystallized into a new discipline or viewpoint, cognitive science or cognitive viewpoint which applies to all disciplines within the humanities. A central instrumentality applied to the investigations of the project is the thinking aloud-technique borrowed from cognitive psychology. The thinking aloud-technique, often relied on within psychology for the study of mental processes in so-called problem-solving situations, was adopted as a means for identifying and isolating the nature of the thinking activity occurring in literature and information searching tasks. The present research report includes a section with a general discussion of the theoretical basis and implications of the research study in which consideration is given to research fields and branches of science that are considered applicable to information retrieval. Coupled with this section is a special treatment on theory based on the cognitive processes and structures that constitute the theoretical foundations of the investigations and experiments.

The findings of the project dealing with librarians' own searches based on written queries reveal that three basic mental attitudes may be discerned which determine the nature of search procedures: Open - Fixed - Semi-fixed. In most cases the librarians tend to prefer concepts derived from the first need formulation in their initial action. Dependent on search mode concepts are recalled

from memory or assimilated from the search environment. The user's own search depends heavily on a possible coincidence between the user's and the librarian's conceptual knowledge in terms of the need and the design of classification systems. In the reference interview knowledge structures have considerable influence on question negotiation processes as well as search procedures. Inter-personal and meta-communicative elements have an effect too. It is observed that the first user statement occurring during the communication phase is mainly presented as a label of the user need. Also pointed out is the fact that symmetrical and asymmetrical negotiation positions strongly determine the nature of information picked up from the user statements as well as the result of the search process.

INTRODUCTION

The reasons for starting the project was to gain more detailed information about the negotiation process between user and librarian in typical reference situations, and to identify association patterns and search procedures in the information transfer processes.

Library school education could no doubt be improved by a more methodological approach to reference work or information retrieval, and by including details of user needs, user interaction with the system or librarian and search procedures.

We are concerned with education of generalist librarians, who have no prior background in particular subject fields, and who may - in certain fields, such as technology - have an extremely weak subject knowledge. During long time of practice the librarian will probably develop quite efficient working methods, and a problem in education is to understand, select and evaluate useful methods, especially for the generalist situation, and to set up a proper training in such methods.

Since 1972 we have introduced methodological elements, especially in reference work and bibliography, taught in fields of technology and in connection with subject analysis in indexing courses, since indexing is partly a preconception of later questions posed to the system.

We have been sensitive to claims from librarians who said they needed training in user interviewing techniques, particularly in subject fields where they had scarce background knowledge (for example the technological disciplines).

Ideas from the project have loosely been tested in the practical training, and observations from student behaviour in classroom situations have been considered in the project.

Thus, it is part of our aim to try to reinforce methods and teaching aids which may improve the quality of the information transfer processes conducted by librarians.

In the investigations we have focused on the cognitive aspects of the information transfer processes. These processes apply to all kinds of information services ranging from public libraries to university libraries and information and documentation services: negotiations, search procedures, adaption or learning processes and guidance or instruction of users.

A characteristic feature of the public libraries is the public librarians constantly handling subject-related questions and concepts outside the sphere of their own formal training and knowledge. Also, the users of public libraries usually cover a very broad range of varying learning and educational levels. In addition, the documents as well as the representation of documents, represent knowledge structures which for the most part are originally derived from scientific domains. Thus, the librarians face a very complicated task of transforming primarily user questions and concepts into user needs and then transforming these needs into the organization of documents in the library or the organization of information in documents.

We believe that similar situations concerning problems of matching different knowledge structures can be expected to appear and noted in university libraries because of the growing reliance on project centered and interdisciplinary learning introduced at an early stage in the university studies where students are rather unfamiliar with terminological concepts and structures in fields in which they are expected to seek information.

The division into - as well as the integration of - several viewpoints or schools, and general subdivision and fragmentation of scientific fields and disciplines, especially within the social sciences and the humanities, followed by specialization in terms of research topics may lead to similar perspectives and situations for the I & D sector.

Although the experiments referred to only involve the public library area and "ordinary users", we believe that some of the results may be useful and relevant to the I & D sector.

Generally most user studies apply observations or interview techniques, which give only cross effects and not the degree of details considered necessary in the present context. Lancaster (3) gives an overview of user studies conducted so far, including catalogue studies, which are of most direct interest.

Ingwersen (4) has studied catalogue use in Danish public libraries, thus bridging Danish and English language and indicating particular language features.

Studies of the librarian's behaviour are also mostly observational. Bunge (5) has studied public librarians exposed to more factual reference questions. The aim of this study was to relate reference work performance and formal education.

More recent formulations of reference problems are given by Bunge (6) in relation to information networks and by Kochen (7) in relation to cross-reference structures in bibliographic tools and in other connections.

Very interesting not only with regard to investigating the reference process itself but also regarding the didactic implementation of such study results is the tests of a descriptive model reported by Jahoda (8).

In her study of user-librarian-communication concerning fiction, Annelise Mark Pejtersen has applied observations and recording (9) while Belkin and Oddy are using interview-techniques in investigating problems concerning the formulation and the understanding of information needs and the match of these with the system (10).

The above mentioned methods are not sufficient for our purpose because they are unable to provide the kind of data and information

with which we are concerned. Hence, we have based our experiments on the "thinking aloud technique".

Using this latter technique certain elements of thinking processes concerning the formulation of user needs, communication and information search may be recorded on tape. Obviously, the conversations between user and librarian may be directly recorded. Thus, the recordings result in verbal protocols that can be made the subject of analysis.

Especially during recent years this experimental methodology has been used in cognitive psychology, for the study of the mental processes occurring during the accomplishment of problem-solving tasks.

Now and then this methodology has been used in library contexts, however without any consideration of methodological problems.

Keen (11) who has focused on the processing of index entries and Mitchell (12) who investigates topics similar to ours rely on the same methodology in their research studies.

Our investigation of literature search processes can be divided into 3 parts:

1. Considerations of mental processes in the light of uncovered library practice as well as existing library theory and scientific theories on language and thinking. These suppositions provide the background for planning of experimental situations and analyses.

2. Considerations of the method in relation to the experimental technique and consideration of the reliability and realism as to the natural situations.

3. Analyzing techniques treating various methods and viewpoints on analyzing the verbal protocols and the conclusions which may be drawn from the investigations.

Not being in the possession of a research tradition or a certain methodology of research we preferred to carry out a broad elaboration of the problem area. We did not intend to gain to very specific results which - in lack of control of hypotheses and experimental techniques - might prove rather questionable.

At this stage we find it appropriate - briefly - to try to relate this project to a research context: Two basic points of view may be adopted: either to understand our investigations as a contribution to science in which the library situation becomes the practical situation which provides the starting point for theoretical studies - or, to view the investigations as a tool for solving practical problems in librarianship (and educational problems), drawing upon scientific research in cases where it may contribute applicable findings.

We prefer to take up the latter attitude and hope that we can both make a reasonable approach to practical library problems and use the results in library education, and at the same time be able to formulate practical problems of librarianship in a theoretical and scientific context and thereby create an interest in true scientific research.

I THEORETICAL APPROACHES IN GENERAL

HISTORICAL REVIEW

In 1950 Calvin Mooers introduced the term "information retrieval", which he defined in this way: "searching and retrieval of information storage according to specification by subject". Yet, Mooers was also a pioneer in the development of coordinate indexing which served as a basis for the use of mechanical methods in information retrieval, and later on for the use of computers.

These pioneering efforts that took place in the 1950's initiated very active research contribution in the 1960's and 1970's carried out by a large number of research workers who have developed theories on information retrieval as well as they have been in charge of the design of practical systems and experimental methods for the study of information retrieval processes and search systems. The object of this research has mainly been information problems and literature search problems within the scientific sector, in particular within the natural sciences and technology. In recent years social sciences and humanities have been included. Hence, you may consider that information retrieval and literature search problems in all scientific areas are made the object of a systematic study.

A characteristic feature of the development is that the initiatives and the efforts have mostly taken place outside the library system itself. It is the universities and their departments of information science and computer science, and it is the documentalists and experts attached to the institutions that publish current bibliographies (American Chemical Society including Chemical Abstract, Institution of Electrical Engineers including Electrical and Electronical Abstract etc.) which both theoretically and in practice have

contributed to the development.

In the light of the historical trends this might not be so odd. If we follow Shera's description we shall have to go back to the late 19th century to find the tendencies which today have caused a rather distinct borderline between librarianship and documentation, between attitudes towards research within the various areas and the research which is in fact in progress.

"One of the influences which induced librarians to divert their energies from the increasingly difficult problems of analysing and organizing recorded knowledge was the new faith in the education of the masses that followed in the wake of the Age of Enlightment. As early as the seventeenth century the growth of mercantilism and later the dawn of the industrial revolution had demonstrated the necessity for a body of workers, who were literate as well as trained in specific manual skills. This practical need was later reinforced by the results of the political revolutions in Britain and on the continent and by the establishment of a rapidly growing democracy based on almost universal male suffrage in the United States.....

....By the decade of the 1850's the public library was becoming universally regarded as primarily an educational agency, an instrument for the extension of the formal educational process throughout mature life.....

....The concept of the library as "the crowning glory of our public school..." (13).

There is a gradually increasing understanding as to creating a closer connection between the extensive theory of the documentation area and the libraries' practice through centuries. Shera has pointed out the necessity of creating an educational connection between the two areas, and in a recently published survey of linguistics and documentation the linguists K. Spark

Jones and M. Kay have presented the following views (14):

"It is significant that most of the original workers in automatic retrieval in this period did not start out from the viewpoint of the librarian; the conventional library wisdom was neglected and most of the work done was characterized by simplifying assumptions about the use of libraries and by optimistic beliefs about the capacities of computers as substitutes for human beings.

Now the traditional librarians are making a comeback, on the one hand because they are beginning to use computers and on the other because the advocates of the new methods recognize that they have something relevant to say about information retrieval. The original computer people have become disillusioned with the difficulties of analysis and retrieval, as they have discovered the complexities of real library use.

At first sight the situation as a whole might therefore be regarded as fairly healthy: the old-style librarians are becoming more modern, while the new-style information scientists are becoming less brash. There is, moreover little doubt that the introduction of computers, even at the level of routine tasks, forces system and consistency on notoriously unsystematic and inconsistent human beings; at the same time, bringing research workers down from the blue sky to face the very real complications and ill-understood problems of information retrieval must be regarded as an advance. Unfortunately, the situation is not, in our view, a really satisfactory one".

In this theoretical chapter we have tried to adopt various theoretical approaches to the user service situation in the public libraries hoping to contribute to the provision of a theoretical sort of material which may improve the daily user service in all types of libraries.

We want to put the same meaning into the word "information

search" as Mooers puts into the word "information retrieval". The starting point being a subject inquiry and the search result being specific titles or information included in books, periodicals, documents, data bases a.o.

At the same time we want to underline that the recent scientific theories within among others psychology, linguistics and sociolinguistics influence the pedagogical research and therefore also the pedagogical practice. The development is directed towards a greater emphasis on methodological learning and less weight ascribed to learning of fixed practice skills and knowledge. A consequence of this changed pedagogical practice is - or ought to be - that the library to a much higher extent becomes a tool in the daily teaching which causes that a specific information retrieval instruction will be required still more in the educational programmes.

Therefore, this perspective will be included in the state of reason for drawing upon a scientific theoretical knowledge base in the education of librarians, as this background material might support the librarians' possible later work with library instruction and information retrieval courses aimed at various groups of users.

INFORMATION SEARCH AS A PROCESS

The search process with which we want to deal appears in fig. 1 as a sequence of steps, logically following one another.

Thus, it is not said that in a practical information search you must stick to this framework. An exact user enquiry in an exact library situation may, from time to time, involve factors which make it faster and easier to follow another scheme or to jump over some of the steps.

Nor might it be certain that a logical classification of the

information retrieval process is identical with the succession which is the most appropriate to a didactic introduction to the subject matter.

With the above reservations in mind we shall, on the basis of fig. 1, discuss some problems relating to the single steps of the search process.

1. Problem situation of user
2. The formulated information need of user
3. User-librarian negotiation
4. Developing the search profile
5. Choice of tools, including files
6. Looking up. Systematic or alphabetic
7. Judgement based on index (terms)
8. Judgement based on descriptions, abstracts, titles
9. Evaluation of the documents themselves

Fig. 1 Steps in an information retrieval process.

Leaving the user problem situation and moving to a verbally formulated need implies various thinking processes of the user which have been suggested and described in an often quoted model by Taylor (15). The information request develops through four steps of which step 1 through 3 are internal representations of the need:

1. The actual, but unexpressed need	The visceral need
2. the conscious, within brain, description of the need	The conscious need
3. the formal statement of the need	The formalized need

4.	the question as presented to the information system	The compromised need

Behind these concepts we find some complicated processes and connections between language and thinking, language and perception, memory and recall, to which psychology devotes much attention and which are, to a poor degree only, clarified.

In the same way negotiation between user and librarian will be subject to rules or habits which are characteristic to people generally communicating and perhaps especially in different professional situations such as a dialog between doctor-patient (16), social worker-client interaction or in a press interview. These situations are treated in the literature, for instance by Karen Zimsen (17) and Peter Harms Larsen (18).

In general these problems of interaction are treated in the emerging fields of "sociolinguistics" and social psychology which are just concerned with the study of linguistic phenomena in negotiations and relations between human beings. A cognitive view on such social phenomena has been stressed by Cicourel (19).

When pointing out that classification and searching in principle is carried out on the basis of linguistic expressions and the connected concepts and conceptual structures, it seems obvious that proficiency in language as well as knowledge of subject field related conceptual structures is of great importance to the information retrieval process.

When developing the search profile and the method of looking-up the knowledge of linguistic phenomena and the involved subject-specific language may be useful - especially to the librarian who has to spread his efforts over many subject

fields without any possibility of losing himself in the terminology of a single subject field and its concepts, and substance. In on-line search you have the same possibility as in manual searches of modifying the search profile during the searching on the basis of the preliminary results.

As on-line searching is still very expensive it would be advisable - as is the case of off-line searching - to continue the preparatory development of the search profile before the search in fact is initiated.

Thus, computerized searching has forced a more consious work with the planning of the information search than usually carried out during manual searching in a library. However there exists no basic difference and the construction of a search profile may also involve for instance considerations of classes of classification schemes and thesauri which are to be searched.

The last 3 steps in the retrieval processes - fig. 1 - involve other types of thinking processes which are linked to a processing of entries in search tools, for example catalogues, bibliographies or indexes, computerized or not, or directly in the documents. Knowledge of terminology, authors and of the literature with its typology as well as subject knowledge, will now be part of the decision whether a subject is relevant or not.

Systematic as well as alphabetical consultation make different demands. Roughly you may say that looking-up in alphabetically arranged systems implies knowledge of terminology and, to a lesser degree, knowledge of subject field structure. Conversely, direct consultation of classified systems and thesauri requires knowledge of subject structure, whereas knowledge of terminology is reduced to recognition of concepts, a process of thought which is considerably simpler than the recall of subject terms involved in an alphabetical looking-up.

In a library search tools and search materials usually are placed near each other. The availability of the search tools within the libraries, especially the easier access to edp-terminals and data bases will cause that the intellectual access to the material, represented by the steps 1 through 8, may be organizationally separated from the physical access which in the library implies verifying, locating and procuring of the material. Consideration has been given to the danger of unqualified library professional searches and ordering of materials causing a drastic increase in the handling of material, which proves irrelevant to the user. These phenomena concerned with recognition and recall of concepts and the expensive noise in the inter-library loans stress the importance of collaboration between intermediary and user.

The central problems concerning need formulation, search file construction, use of search concepts and judgement of entries are of a linguistic and psychological nature. This means to concentrate on syntax and semantics and to follow up and further develop the linguistic ideas and theories of Spark Jones (20), Fillmore (21) and Spang-Hanssen (22) a.o. based on a search point of view as well as implementing the relationship between language and thought in retrieval theory by application of psychological theories and findings of Vygotzky (23), Piaget (24) and Bruner (25).

In this general outline of information search problems, mention must also be made of conceptualizations and theories within other scientific areas which may be of importance to the information retrieval processes and their aim: to create a connexion between user needs and the contents of the literature. The sociology of science and cognitive theories will be areas of science which are most likely to underpin and supplement library practice and experience.

In psychology behaviourism's rejection of the study of thought processes and other "internal" processes has created

a gap in the psychological research which has not been filled until recently concurrently with the development of a cognitive psychology.

We expect that current trends in cognitive psychology may contribute to a better understanding of the processes involved in negotiations and search procedures. The central, theoretical ideas about the functions of the human brain are as follows (26):

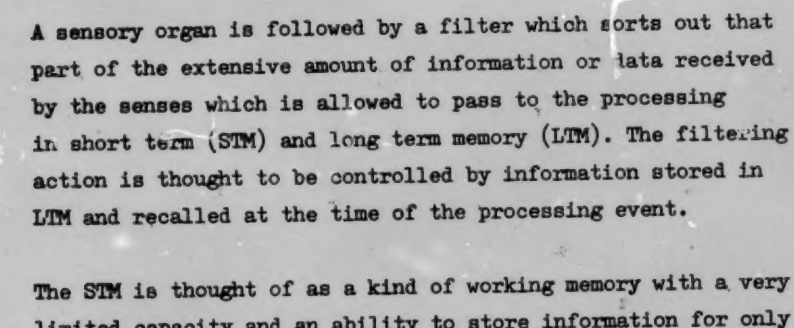


Fig. 2

A sensory organ is followed by a filter which sorts out that part of the extensive amount of information or data received by the senses which is allowed to pass to the processing in short term (STM) and long term memory (LTM). The filtering action is thought to be controlled by information stored in LTM and recalled at the time of the processing event.

The STM is thought of as a kind of working memory with a very limited capacity and an ability to store information for only a very short time, seconds or minutes. The capacity is expected to be limited to around 7 information items, usually named "chuncks". It is not easy to define what a chunck means.

We can approach the concept "chunck" or information item by considering a telephone number. The digits are unrelated and represent chunks. If we are asked to remember the telephone number for a short while, we can rehearse the number. We will then experience that the rehersal process becomes more and more difficult when the number of digits increase beyond 7.

However, if two digits are recognized as a well known street number or more digits recognized as well-known area numbers, these digits can be remembered as only one information item. The digits are coded and we may think of a transaction between STM and stored information in LTM.

This may allow a rehersal of far more digits than seven and still be within the capacity of around seven information items. The long term memory is considered to have a nearly unlimited capacity for information storage. However, the storage and recall of information from LTM involves a coding and decoding process. This implies that the stored information is not necessarily accessible in a given situation. A cognitive point of view helps to understand the mental processes involved.

The central point in the cognitive view may be defined as: "any processing of information - whether perceptual or symbolic - is mediated by a system of categories or concepts which, for the information-processing device, are a model of his world" (27). The cognitive view on mental processes may be visualized in a simple way, which may be as good as any, because our knowledge is very restricted. The cognitive structure - the system of categories and concepts - may be illustrated as wall maps as we may have seen them in a classroom in the primary school: a battery of maps hanging in the ceiling and which could be pulled down. Certain stimuli may activate a particular map in LTM on which the individual operates in the thinking process.

The same concepts may appear on different maps in different relations, and total changes of maps may occur in a sequence of mental operations or during a conversation. Such terminological maps are suggested as a tool for setting up search profiles and for structuring a subject field. The idea was proposed by Doyle (28) and it has been pursued in various forms in bibliographic work.

There are several concepts connected to this understanding of memory and the thinking processes: "schemata" - "scheme" - "knowledge structure" - "frame" - "state of knowledge".

The terms "scheme", "schemata" were used by one of the first memory research workers, Barlett, who in the beginning of the thirties carried out some memory experiments in which persons participating were to reproduce stories among which was a famous experimental-text presenting a Red Indian legend "The War of Ghosts" (29). Barlett observed that (the English) subjects made systematic errors in the reproduction, and explained it as a lack of schemata concerning Red Indian culture, hindering the subjects to place the details in a structure.

These thoughts have gained dissemination within various disciplines. Further, the word schemata has been adopted by others, for instance by Piaget, in a much altered sense. In this report we prefer the designation: knowledge structure.

Two different groups of knowledge structures may be distinguished. One type representing the private knowledge of the individual and the other the more formal knowledge shared by other individuals as a result of education. These are referred to as episodic memory and semantic memory. In relation to library education it is of interest to know how strongly episodic memory influences the librarian's information search and how the semantic memory, including library training and skills, is employed.

For a fuller treatment of the information processing models presented here we may refer to a textbook by the two distinguished psychologists Norman and Lindsay which also deals with the physiological description of sensory organs and with speculations on the existence of filters, short term and long term memory in the nerve tissue in the brain, fig. 2.

This textbook also gives an overview of the psycholinguistic

aspects, of problem solving behaviour and decision making which is considered highly relevant for the understanding of the negotiation and search process. Mentioned is also the special experimental technique, including the analysis of verbal protocols based on "thinking aloud" (30).

Considerable importance must also be attached to "topic concepts" in the light of the function of the memory. The cognitive structure controls the reproduction of topic concepts by indicating what is to be produced, what is not to be produced, and what may be produced under the circumstances.

This idea may, for example, serve to illuminate "errors" we make when giving evidence, the difficulty in remembering events from the childhood where the cognitive structures are expected to be of quite another type. The cognitive development of children is a.o. studied by Bruner (25) and Piaget, the latter to a less degree from a psychological angle and rather from the point of view of knowledge theory (24) as well as by Vigotsky from a materialistic dialectical point of view (23).

The extensive theories and experiments mentioned may be of much value to understand the mediation and search processes in the library. At this point we shall confine ourselves to pointing out the consequence that every human being has his own special cognitive structure by means of which he perceives and "processes" the search tools of the library, arrangement of books and the contents of the literature mediated.

The condition of conducting a reasonable communication is that the cognitive structures possessed by different people have some features in common. The condition of performing a literature search is that the structures formed by the classification systems are perceptible and comprehensible to the users, that the language signs used in indexing create

uniform schemata, etc.

Perhaps the above conditions might contribute one of the reasons why classification and indexing are controversial problem areas. Each of us has a right to give an opinion on which structures we find most useful. However, there is no basis for - in absolute terms - to claim that one structure is to be preferred to another. There may be a tendency to consider "scientific" structures as being preferable. Thus, in a scientific system, you will not classify the whale as a fish.

In addition, we shall mention a work from the field of sociology of science which serves to illustrate what we may call collective cognitive structures. First and foremost T.S. Kuhn has reflected on the development of the scientific cognition based on the historical development of science (31). The crux of the matter is - according to Kuhn's views - that the building of science has not been erected by stepwise laying brick upon brick. The cognition of reality has taken place almost like "jumps" through scientific revolutions. Kuhn coins the expression "paradigm" denoting the conceptual knowledge structure which - for a period - prevails in a scientific field.

The paradigm determines how problems are attacked, which problems may be accepted and made the object of studies, which concepts that may be defined and which concepts that might be related in a knowledge structure. He describes two kinds of research: "puzzle solving" carried out by most scientists within a paradigm given. However, "revolutionary research" arises when the scientific results are mutually conflicting or when the paradigm does not accept essential groups of problems. Einstein's suggestion that mass and energy was linked together through the relation $E=mc^2$ founded a new paradigm and thereby prepared the way for new experiments within atomic physics and astronomy which it had not been possible to carry out within the framework of the

old paradigm.

It is due to Kuhn that he pointed out that the conceptual instrumentalities possessed by science at a given time is essential to the scientific research. Several psychologists, educators and sociologists have extended Kuhn's view to including all human perception of knowledge and cognition as well as research outside the scientific fields. Thus, the concept of paradigm has exerted its influence also outside the field often named "science of science".

The mechanisms often described in paradigm theories also have implications for the information retrieval. At a time where a paradigm changes or during a pre-paradigmatic period there will be a chance of a break down of the knowledge structures of the classification systems or that the literature becomes more difficult to classify. That does not only apply to the scientific classes of the systems, but it also affects the more practical classes where changes of social views or changed production conditions may reveal an antiquated classification structure.

Several scientific disciplines seem to be in the process of changing paradigm where several "schools" compete when production structures are changed, and where new technologies, nuclear energy, computer technology change the usual working routines.

We, too, may find ourselves in a period where cross-disciplinary activities are getting more and more common, and where ideological and political views interfere with the structure of conceptual systems and research. This influences both the topic relations treated in the literature and the need situation which at all levels underlies the user's requests. In such a situation the body of public library literature will quickly reflect these conditions and thus influence the ordinary individual.

This division into as well as the integration of several viewpoints or schools, and the general subdivision and fragmentation of scientific fields and disciplines, especially within the social sciences and the humanities, may lead to similar perspectives and situations for the I & D and library sectors.

Hence - seen from a paradigm-view - there will be a reason for looking at the personal, subjective elements which influence the retrieval process. Fig. 3 shows the essential possibilities of interaction between user, librarian and literature. The figure is divided into a user area and a document area.

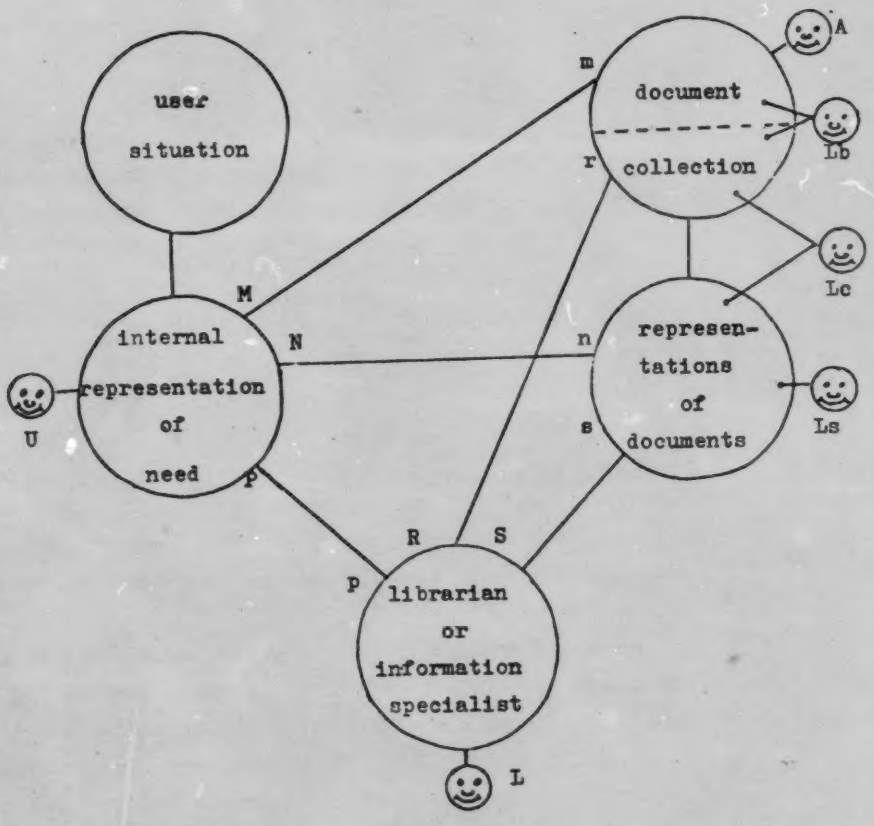


Fig. 3. Relations between user and documents.

We can relate cognitive processes to different persons playing 6 different roles in the storage and retrieval process.

1. The user U, who is responsible for converting his need into a linguistic formulation. This need expression may vary accordingly as he searches himself directly in the material collection (Mm) through bibliographic tools (Mn) or if he asks the librarian to help him (Pp), involving the steps mentioned by Taylor (p. 10).

2. The librarian L, who every day guides users and perhaps does the searching on behalf of the user either direct in the collection (Rr) or via the aids (Ss).

3. The person Ls, who is in charge of the design of search systems and thereby the structuring of a subject area and the extension of special indexes and linguistic aids intended for the user of the system.

4. The person Lc, who classifies or indexes the individual documentary items.

5. The person Lb, who carries out the selection of informational items and thus deciding the choice of documents which are at all available in the library or in the information system.

6. The person A (the author) who chooses and structures the topics treated in the individual document.

In general we may say that a special library with a specially adjusted classification system has a good chance of being in a situation of paradigm concensus between all categories of persons. So the library will to a large extent avoid a lot

of the search problems which a more universal library has to solve.

On the contrary the special library may have problems with a more complex literature and very specific user requests which may often be on the verge of the collection registered.

Before finishing this chapter we would like to mention a few scientific areas more which may be expected to contribute to a more fundamental understanding of the retrieval processes.

Firstly the sociolinguistics which is a new border area between linguistics and sociology. The sociolinguistics is of an interdisciplinary nature and connects linguistic observations with sociological descriptions.

The Englishman Bernstein was the first who tried to formulate central problem areas especially in relation to the conditions of language and class affiliation. He claims that the workers' children develop a restricted code which is characterized by a simple syntax, richness in metaphors and a frequent reference to practical situations, while middle class children learn an elaborated code with a more complex syntax, a higher degree of abstraction and a more systematic graduation in broader and narrower conceptual categories (32).

In spite of essential criticism Bernstein's theories have been widely disseminated and you may raise the question about the connection between proficiency in language and retrieval skills.

In a research library context the problem is hardly of relevance as the user-group may be expected to be familiar with the paradigms of the discipline and use an elaborated code like the other persons mentioned in fig. 3. A special problem may arise in relation to the university library's service to students working with project-centered forms of

studies. In their problem formulation and search profile they may be, in a higher degree, inclined to use the every day concepts.

In the public libraries considerations of elaborated and restricted codes will be more relevant, and there may be a reason to assume that the connection between proficiency in language and retrieval skills may be of importance for using the library tools. This may lead to considerations on user instruction.

Close to this area is reading capability. Recent Danish investigations covering children from a whole year - the 6th in public schools - compared with similar studies 20 years ago, shows that the reading capability demonstrated by the pupils of the present years does not follow the gauss curve any longer. The children are separated into a large group which consists of better readers and spellers than 20 years ago and a smaller group which numbers more backward readers than 20 years ago. The explanations are not only directly social ones (34).

On the border between linguistics and psychology a special discipline, psycholinguistics, has emerged which treats the connexion between cognitive processes and proficiency in languages.

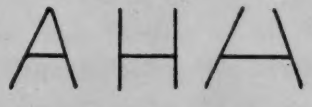
In their recent development humanities have been influenced by scientific fields closely related to the practical technology. Especially the design of computers and the following development of computer language and general function descriptions, not relying on limited circuit and voltage explanations, has contributed to an increased psychological interest in describing processes in the brain without passing to a detailed nerve-physiological treatment. In "Design for a brain" Ashby has given an introduction to the technical-scientific views which may be suggested (35).

Furthermore, computer science experiments with simulation of human information processes ranging from perception and pattern recognition to problem solving and translation have contributed to a psychological innovation. This computer science area is called artificial intelligens (AI) and the corresponding approach in psychology has been named "information processing". In a Swedish psychological survey (36) IPP is used for information process psychology.

De Mey has described the cognitive viewpoint in an epistemological framework, and we may show an example which treats the problem of ambiguity in connection with perception - a problem which to a great extent is relevant to the information transfer processes (27). In artificial intelligence processing of information by pattern recognition experiments have been carried out with application of computers over the years.

Though, in every way results have fallen short of the expectations, they have inspired very extensive studies of the basic problems which have been discovered during this work.

Thoughts and experiments have in a historical context passed through various stages, the first one being a monadic stage. In perception research the problem was regarded as a comparison of the percept with a stored picture; so the letters



could be compared to stored A and H, and when compared it was decided to which category the letter perceived belonged. The problem of ambiguity is obvious when regarding the third letter example, and in the structural phase the experiments were extended to be an analysis of various attributes, i.e. number of straight lines of the letter and the categorizing consisted of a combination of various attributes.

Hereby - in certain cases - less ambiguity, though no proper solution, was achieved. At the contextual stage a context is included i.e.

THE CAT

However, CAT could be an acronym for "Continental Hydro Trafic" and the clarification of this ambiguity needs further context:

FELIX THE CAT

The question then raised is: How much context is necessary?

This leads to the cognitive point of view demarcating context to be the context which the information system (man) can produce itself. It is the system's image of the world, its "world knowledge" which decides which ambiguity can be eliminated.

In automatic language translation the monadic stage represented word to word translation. Homonym problems created a structural phase during which the structure of sentences - i.e. syntax - was the central approach. Ambiguity phrases such as the famous

"Time flies like an arrow"

created the contextual stage and has also raised the question: How much context is necessary? Famous is also

> "Eleanor and Jane wanted to go to the movie with Sam and Bill, but they didn't have any money".

No syntactic and semantic rules help us to understand the meaning which has to be based on social conventions to solve the ambiguity problem introduced by the word "they".

The cognitive stage again implies a context which is produced by the receiver's knowledge structure. This again leads to an interest in memory and questions concerned with the kind of information which must be stored in computers dealing with perception and translation tasks.

One has to bear in mind that the first stages are included in the subsequent ones. The building becomes more and more complex.

A similar cognitive view may be applied to the information retrieval processes. Ambiguity problems (noise problems) are indeed present in our field. We may suggest some characteristics with regard to the stages mentioned.

The indexing and search process may in the monadic stage represent the assignment of only one index term or signature to one document. The structural stage may be considered as representing facet systems of different kinds, syntax systems like PRECIS, KWOC indexing based on the in-built syntax of title tabulations and descriptor-based systems. The contextual stage involves natural language, combined with for instance weighting including natural language thesauri to cope with the ambiguity in the natural language. At this moment we believe that the question about how much context is needed will lead to a dialectical cognitive stage implying a context of information which is produced by different knowledge structures of not one, but two receivers:

A: The individual librarian/user's knowledge structure in the individual search with regard to his actual need situation receiving information from B (see also fig. 3).

B: The knowledge structure inherent in the vocabulary structure of document representations - in perhaps the total complex of computerized files - which theoretically is identical to all

author-structured combinations of concepts with regard to information received from A.

First behind the structures of B the searched documentary items are located: the right topics in the right documents matching the individual user need.

Shortly, we believe that the ambiguity problem in information retrieval - the noise problem - is of the same dimensions as in language translation or perception.

We also believe that the cognitive stage won't be reached until AI have succeeded in solving their problems.

But we fear that already the contextual stage will lead to a formalization as reduction of the structures of author-created concepts. In the man-machine dialogue this situation will force the user to produce contexts that are compatible with the conceptual structures of information stored in the totality of natural language files.

II THEORETICAL APPROACHES TO THE PROJECT

We are interested in clarifying which kind of knowledge the librarian tries to remember (which schemata, knowledge structures, frames), and which thought processes, working routines, and procedures she develops and relies on, especially when dealing with the information needs of the users with whom she is confronted. Of interest to us is also to discover why these devices and steps are activated. Working/search routines are defined as limited (automated) action units which serves the purpose of getting an overview of a part of a problem, for example verifying a document in a catalogue, getting a reference to a class in the classification system etc. In the following we have avoided the term "search strategy" which - as we see it - implies preceding considerations

on the entire search process. Instead we prefer "search procedure" because of its "descriptive" connotations. Working/search procedures are defined as consisting of different combinations of working/search routines. In our attempts to define the information need we loosely use a formulation by D.M. MacKay: "....a certain imcompleteness in his picture of the world - an inadequacy in what we might call his "state of readiness" to interact purposefully with the world around him" (37).

The problem, then, is how the intermediary/system comprehends and interprets the real information need of the user and how the intermediary/system reacts to satisfy the need. De Mey has stated that "The central point of the cognitive view is that any processing of information, whether perceptual or symbolic, is mediated by a system of categories or concepts which, for the information-processing device, are a model of his world" (38) - whether the device is a human being or a machine. This model of the world is determined by the individual and social/collective experiences, education, training etc. This indicates that the problems in information transfer are of a fundamental cognitive character.

In a study of the historical development of the cognitive processes Luria (39) isolates two different kinds of human approaches to the classification of objects. a: abstract/ categorical classification, where a subject sorts out an abstract concept and chooses the objects which can be included under this concept. b: the concrete/situational classification, where the subject tries to involve the objects in different concrete situations from the practical life, hereby classing objects which belong together. The processing of information which is conducted and the classifications schemes which finally are chosen, are determined by that experience which is dominating the activity of the subject. This experience is again depending on the historical conditions for the life of the subject. The classificatory approach seems to be in harmony with

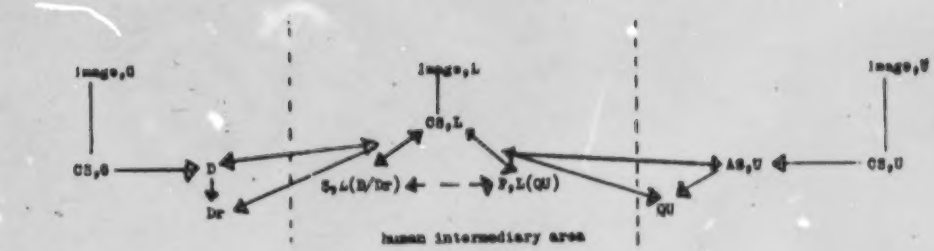
Vygotsky's dichotomizing of concepts into scientific and everyday concepts (23). Furthermore, the two kinds of classification may be similar to the frame and script concepts of Minsky and Schank (40).

When relating these cognitive views to the library & information sector we imply the distinction between categorical and situational classification, when we use the concept of knowledge structures. It is appropriate to have the distinction in mind in the analysis of interactions between different knowledge structures i.e. user-librarian negotiations, user-system inferface etc. Also, it might be fruitful to understand the user-need situation, as well as the following formulation of the information need, in the light of a situational viewpoint.

When we focus on the intermediary/librarian's situation and consider this as a professional problem solving situation, we have to make a second distinction between her knowledge structures: A: Knowledge structures concerning library and information work (documents, document representations, working procedures etc.), B: Knowledge structures which concern private conceptual knowledge, C: Actual perception of the user's verbalized information need and problem situation.

N. Belkin has presented a model of the communication system within information transfer, as seen from a cognitive viewpoint (41). This model relates to what we might call the traditional information science, in which there has been paid little attention has been paid to the role of the human intermediary between user and information system.

Our concern, also as teachers in information retrieval, is the role of this intermediary. Fig. 4 outlines the communication system, as we see it from a public library point of view and stresses the information processing shown in fig. 3.



: partition ——→ : transformation ←——→ : interaction

Image	- knowledge of and perception of reality	CS	- conceptual knowledge
G	- generator	AS	- anomalous state of knowledge
L	- librarian	QU	- query as formulated by user
U	- user	P,L(QU)	- L's perception and picture of QU
D	- document	S,L(D/Dr)	- L's state of knowledge of D/Dr/etc.
Dr	- document representation		

SK/PI, 1979

Fig. 4 The public library communication system from a cognitive viewpoint.

The model indicates some of our basic theoretical assumptions. We suggest that the conglomeration/integration of the different knowledge structures, possessed by each individual, is termed ones image of the world. In the model we have marked the 3 main individual images which have to be connected in the information transfer process: the images of the user, the human intermediary and the generator. Add to this as important factors the images of the selector, the indexer and the system designer, which in the model are implied in the notation "Dr.".

In an actual information transfer situation, parts of the different individual images have to a certain extent to be harmonised concerning a special field of topic or interest, if the communication process (the match) shall succeed.

The right side of the model illustrates the user need formulation process, where the user's knowledge structures

(CS, U) in a particular area of interest are considered incomplete from a user point of view (what is termed 'anomalous' by Belkin), and consequently is transformed into what is called 'anomalous' state of knowledge (AS, U).

When considering the transformation from AS, U to a query presented to the human intermediary (QO), one has to bear the Taylor-model of the information need formulation in mind (page 10). The human intermediary to whom the query is presented possessed, as mentioned, a private conceptual knowledge of the topic/problem, which consists of more or less well-established knowledge structures. These knowledge structures are activated in the situation (CS. L). On the basis of the query formulation by the user, and of other psychological and social interpersonal relations, the human intermediary creates a picture of the need, and perhaps the need situation (P, L (QU)). This picture can be elaborated thrcugh the user-librarian negotiation in which the CS, L and S, L (D/Dr) are involved. The knowledge of documents, document representation and working procedures (S, L (D/Dr)) is connected dynamically with the CS, L and activated in the situation as the professional means to match the picture with the system, i.e. the documents and the representations of documents (D & Dr).

On the other side we have the generator of texts/documents who, in the terms of Belkin, "wants to communicate his or her state of knowledge about this subject, (CS, G) and his or her values, intentions, purpose and knowledge of potential users (and) transforms this conceptual state into a state of knowledge identified as information" - (42) in our model called documents (D).

The model emphasizes the main "match" points in the information transfer process: the negotiation/interaction between different knowledge structures of user and human intermediary and the interaction intermediary ◄► document/ document representation: It stresses the possible implications

and complications to be considered by the designer of an automated interactive user-machine system, if it is to replace the human intermediary: the interaction between private knowledge, actual perception of needs, professional knowledge and the development and use of working procedures. The work of for example Oddy (43) and Bivins (44) points in this direction. Not implemented in this study is the shown transformation of the conceptual knowledge of the generators into structures of retrieved systems (D→Dr). Neither illustrated nor investigated is the very important question: How is the information retrieval used by the client or why do needs arise in individuals as well as in society?

III ASSUMPTIONS AND HYPOTESIS

Our main interest i 1976 was to gain a more detailed understanding of the cognitive processes during the actual performance of a search or during the negotiation between user and librarian. The areas of interest are shown in fig. 3. We were interested in the mental development of an information need and request as articulated by a user, and the mental activities involved in the user's own search. Furthermore, the librarian's view of the user request and the associational paths followed by the librarian in order to unveil from the user that information which is useful (in order to locate the relevant literature/information) in the information search.

We have applied the Taylor model (page 10) of user information need formulation in fig. 3 by referring to the user's whole information situation and by introducing a step of internal representation of the need, on which the user can decide his further trails. As discussed by Taylor the compromised question may only partly cover the true need and reflect an expectation as to the capability of the library system.

We have considered the reference process as a problem-solving task, and did expect to unveil different mental procedures,

such as learning processes, remembrance etc. We did expect the librarians to act on certain clues from the user in a way that one could expect to be analogous to tasks of medical diagnosis by physicians or trouble-shooting tasks performed by technicians in mechanical or electronical repair situations (45).

During the planning of the first recordings we expected to be able to observe general problem solving behaviour enabling us to pay special attention to the study of topic relations.

Furthermore, we were aware of the fact that experienced librarians under certain circumstances would show a stereotype behaviour due to their working experience according to which this behaviour usually would bring about appropriate search processes.

This problem solving behaviour also implies that the subjects formulate hypotheses concerning solution methods, and that certain hypotheses are fixed and used repeatedly, even if distinct signals appear indicating that the method is not applicable. Built into the first test questions was therefore the trap that the answer was to be traced at an unusual place in the literature. In this way, a distinctive problemsituation for the subject would arise.

In general, we expected to include theories from library science/linguistics concerning topic relations and structural topic relations in classification systems in the analysis.

This was i.a. based on an assumption that the librarians, before implementing the search itself, would undertake a deliberate mental consideration of the nature of the problem, as well as possible solutions, and only afterwards begin action.

The first recordings showed that this assumption was wrong, since the librarians in the professional problem solving

situation primarily prefer immediate action to deliberate mental consideration. Thus, it became necessary to isolate a number of working routines relied upon. Besides, it appeared that, to a great extent a set of working routines have been established within the profession to cope with the cases where librarian's normal work procedures do not suffice. This means for example that librarians tend to transmit the query within the professional information environment to be dealt with by another department/institution. Hence, a greater part of the investigations than calculated had to deal with problems in connection with working routines.

It was our intention too, to study to which extent private experience would be included in the problem solving (episodic versus semantic memory). We tried to build this problem area into certain query formulations.

IV EXPERIMENTAL CONSIDERATIONS AND DESIGN

In our project we have used verbal protocols derived from tape recorded thinking aloud activities and processes in public libraries. We have borrowed this experimental technique from psychology, where it has been used in the study of cognitive processes, especially concerning problem solving tasks (46). Byrne (47) has given a brief survey of the development and use of the thinking aloud and protocol analysis techniques. Traditionally, it has been applied to limited problem situations - by de Groot in his study of chess ability - and applied by Byrne and Bhaskar/Simon to more complicated problem situations such as planning of meals (47) and problem solving in engineering thermodynamics (48). In the studies of information retrieval processes the technique has been used by Keen in a laboratory experiment on the processing of printed subject index entries during searching (49).

EXPERIMENTAL CONSIDERATIONS

Thinking aloud technique and protocol analysis has a number of advantages over for example systematic introspection, although some problems remain. Two important objections against the thinking aloud technique may be pointed out. Firstly, the methods are obtrusive, which means that the subjects know that they are observed and thereby may be expected to change their behaviour. Secondly, the demand of verbalizing thoughts may change the subjects' thought processes and create an artificial situation. Finally, there is the question of interpretation of the verbal protocol.

On the basis of our experiences we may summarize our considerations concerning the objections. Obtrusiveness in this kind of investigations is unescapable. Thus, we regard it as very important to discuss with the subjects the natural situation versus a more artificial experimental situation and hereby organize the experimental situation. We have tried to establish a situation felt natural by the S's and acceptable by means of these discussions as well as a general instruction of each S in the experimental situation. We have not noted any essential changes in the working routines of the S's. Whether the demand for verbalization of thoughts changes thought processes is difficult to answer. Undoubtedly the thought processes become more conscious because of the verbalization. Byrne states that thinking aloud should be restricted to cases where the S's find it easy to verbalize. Presumably the very best guarantee of this is when S' would rather think aloud than not. In the present study several S's have stated that the verbalization does not seem so far from the normal working routine in which they small-talk with users or themselves throughout the search.

A second approach to the verbalizing problem is derived from the theories concerning the relationship between thought and language. It should be mentioned that Vygotsky in his study of thought and language deals with several phenomena of

importance to this discussion for example the concept and phenomenon of inner speach, which Vygotsky regards as a process effecting the transition from thought to word (23).

To prevent misinterpretation of the protocols we have developed what we call self-confrontation, which means that the S's and the observer make repetitive runs of the recorded tape immediately after the recording. The protocols are transcribed, including observation remarks relating to the behaviour of the S's, to improve the clarity.

It is our opinion that thinking aloud minimizes the danger of confusing past and present states of knowledge, which means that it need not be confined to tasks of short duration, and highly complex tasks can be analysed too.

EXPERIMENTAL DESIGN

The experimental design includes the method of collecting primary material as well as the planning and implementation of the experiments, and the preparation of the materials for analysis.

It has not been difficult to apply the method to experiments concerned with search procedures when users or librarians conduct a search on their own. On the other hand, during the experiments a set of problems necessarily arise which imply user-librarian negotiations. Two series of experiments have been based on written subject queries which represented information needs of users not present. In this case the librarians were asked to think aloud during their search. At the same time they were observed to collect information about important actions. For instance, it was noted which tools they used during their search. The search is terminated when an answer is anticipated or - in negative cases - when the librarian would normally terminate the search. The actual provision of a book or a reference has not been requested and relevance considerations are thus outside the study.

The outline of the experiment has been as follows:

	Subjects:
A. Exploratory recordings of communication and search. (Pilot project)	Technicians, 1 librarian and 1 student
B. Training in recordings of search (1st series). (Written topic questions). QA and QB	20 librarians and 7 non-librarians, not especially familiar with libraries
C. Experimental recordings of search processes (2nd series) (Written topic questions). Q1 and Q2	13 librarians
D. Experimental recordings of user search, user-librarian communication and librarian's search. (User information needs articulated by the users themselves)	3 librarians and 5 non-librarians

A. *Pilot project*

To see if the technique was useful at all and applicable to our complicated problem solving situations in libraries we started with exploratory tape recordings of a) information search conducted by a person from the project and b) of dialogues conducted by a member of our team and one non-librarian. This provided important information concerning type of tape recorders, noise from activities taking place during recording and ideas of experimental setting.

B. *Training recordings*

The information search exploratory recordings led to series of experiments for the purpose of training both experienced librarians and users (non-librarians) in the experimental technique.

The 20 librarians participating in the experiments possess several years of library experience, either in reference units or lending departments of libraries covering both the province and the large cities. Both categories deal with subject inquiries. Often lending department staff have the first contact with users and make the referral to the reference department. In larger libraries some subject specialisation exists, mainly in book selection. Difficult questions may be referred to such specialists.

Library education in Denmark follows straight on from high school (gymnasium) exam and - unlike many other educational systems - it is not preceded by any in-depth subject training. Until recently library education comprised very short courses (10-20 lessons) in a vast number of subject literature specialities, mainly covering the central items. This pattern has changed, and longer courses (60-90 lessons) in selected subject fields, with the opportunity to pay more attention to terminology and structure of a discipline have been introduced. The S's have gone through an older form of library training.

The "non-librarians" - the users - were chosen among people, about whom we knew that they had a limited library experience.

For the purpose of making the S's familiar with taperecorders and with thinking aloud during search, the training programme was considered sufficient, and it proved to be so. Furthermore, we obtained important knowledge partly regarding the experimental setting and partly concerning the substantial problems with which the protocol analysis methodology had

to cope.

After an introductory meeting we started the programme by posting taperecorders and test-questions (QA and QB) together with a brief instruction to the participating S's. However, the resulting protocols were very heterogeneous, and it was decided, for the rest of the programme to use an instructor during the recordings. The instructor ensured that:

> the S's were alerted to play their usual role at the beginning of the recording
>
> the S's reported their "thinking" while things happened and did not summarize events that had happened
>
> the S's were guided, if the question type made them uncertain about their role. This happened if the librarian, in a natural situation, would have asked a user for further information.

We also found that it was necessary to make observations during the recording to get information on details such as use of tools, arrangement of material, and behaviour of the S's which, especially in pauses during speech, would never be recorded otherwise and thereby get lost for ever.

Finally, after recording, the S's were asked to comment on the search and the recording situation on the basis of rerunning the tape and discussion with the instructor/ observer. Later on this postrecording-sequence was developed into selfconfrontation.

In group sessions with the participating librarians after the test training programme some smaller problems were classified. It was believed that certain traps were included in the questions, and such traps were searched. Uncertainty

regarding the future use of the protocols and results was also mentioned as an influencing factor.

It is intensely discussed among psychologists how much information should be given to S's before an experiment. We have taken the standpoint that efforts should be made to inform and answer questions about the experiments as far as possible, and we expect this to have very little influence on search procedures and negotiations. This is loosely confirmed in classroom situations where negotiation "plays" do reveal important mechanisms, even when the theory is discussed in detail.

It was also evident from the test recordings that pauses were unacceptably long. The S's were confronted with this opinion and claimed that insufficient instruction and psychological barriers, preventing easy release of ideas, were the main reasons.

Better instruction in the experimental recordings (2nd series) did reduce pauses. However, long pauses still appeared during search activities such as consultation of indexes or documents, and they were also observed when S's moved from one place to another in the library.

The test questions in the training programme.
All 20 librarians received the following written queries:

QA: The weather forecast offered by the telephone company sometimes gives a degree-day-figure of the previous day.
Find a definition of this weather parameter.

QB: Problems involved in oil-welling in Greenland.

At the planning stage of question QA we wanted to create a problem situation for the S's. From observations of search procedures in public libraries (50) we were aware that the

librarian might try to locate titles in a first attempt. We checked that books on meteorology in a normal collection would not provide any answer. We then expected that the negative results would initiate a series of topic-topic relations and maybe indicate an underlying mental map, which might be active in a recall process for provision of ideas that could change the line of search.

An adequate line of thought would be to anticipate the receivers of the piece of information indicated in the query (the degree-day-figure). It is used by fuel oil dealers who offer automatic refilling of domestic oil tanks, and any book on heat and ventilation was able to provide a definition.

While QA was a factual question, QB was chosen as a broader question. The QB type of question was expected to activate different aspects in the S's mind - social, economic, legal, technical - which would be guiding the subsequent search process. All S's - both librarians and non-librarians - should have a good chance of creating association trails, which might be more influenced by private experience than the first question, QA.

The QB-type of an experimental query led to methodological problems, since the broadness of the question caused an unnatural situation to the S's. Several librarians refused to continue before they had requested more information from a user. Some regarded the instructor as user and tried to make him supply additional information about the query. Obviously this type of question was too broad to function as an interlibrary request or telephone request, which was supposed to be the situation in which QA and B were given.

C. *Experimental recordings*

In this second series, the results of which we intended to use for analysis, much attention was paid to the instruction of the librarians before the test. The instruction was

carried out by two students, who later reported their experience in their thesis (51).

The main points in the instruction were:

> The librarian should treat the question as an inter-library or inter-departemental request and perform her normal routines including decisions to stop searching. She should try to think aloud also when skimming indexes or moving around in the library.
>
> She should report to the recorder which tools or documents she is using.
>
> The instructor is not assumed to play the role as a user and should not be approached during search. The observer should stay out of the way, but try to observe the activities.
>
> After the recording the instructor and S's listen to the recording and the S's are asked to verify bad or faint comprehensive passages or to add activities during pauses or mental pictures occuring during the experiment (self-confrontation).

The experimental group in these recordings consisted of 13 librarians out of the 20 participating in the training recordings, 7 librarians were working as lending librarians (marked "U" in tables), 3 were reference librarians (marked "L") and 3 performed both functions (marked "UL"). All recordings have been made at the S's own libraries and in their special department.

The written test questions were as follows:

Q1: Which marking scale is used in the assessment of (technical) draughtsmen?

Q2: Does Danish snaps freeze in a freezer? The freezing point of Danish snaps.

Q1 and Q2 were both factual questions, which proved most successful in the training programme series. Both questions should provide an opportunity to relate the topic to a particular class and to broaden the search to additional classes. So in Q1 main group 7 will contain technical drawings, but two classes in main group 3 will deal with government publications and education. Q2 points to three subject fields in chemistry, chemical technology, and domestic affairs.

The test questions were selected from the area of technology and adjacent fields, but this does not imply that answers should necessarily be found in material classified as belonging to the technology groups. The reason for preferring this sort of questions was that we might expect a minor risk of choosing questions which coincided with a strong subject knowledge among the S's. To subject specialists or special librarians the questions may seem trivial. To the S's, however, the questions presented a reasonable degree of difficulty. 12 recordings have been implemented in relation to test question 1 and 12 relate to question 2.

The protocols proved to be much more uniform than earlier ones. The instructor did not become involved in the search, and according to the S's the thinking aloud appeared much more automatic.

D. *Experimental recordings of user-search, user-librarian communication and librarian's search processes*

These experiments focused on the user-librarian communication and the information search procedure.

In the communication exploratory recordings (part of the pilot project) different experimental settings were tested.

In the discussion of these, the experience obtained during the training programme were included and led to the following considerations:

The relations between librarian and client during the search constitutes a special problem, since independent thinking aloud is impeded, when the participating client and librarian accompany each other. In this situation one might consider a direct separation between the two participants. We agreed that this should depend on the individual librarian's usual working routine, due to the observation that to a great extent it is the routine that determines whether a user should be actively involved in the search.

A separation implies that the user and the librarian individually may think aloud while amplifying the need/identified need. Afterwards a communication process between the participants will take place for the purpose of clarifying points or asking questions.

Without separation the result will be user-librarian negotiations of topics and search possibilities as well as small-talk with themselves. This seems to be a rather frequent phenomenon.

When applying these methods it is necessary that the participants - after the recordings - have enough time to listen to the recordings in order to supply additional information on thoughts, images, etc., since so much will happen during the experimental situation itself which is impossible to report to the taperecorder.

We found it necessary that both the librarian and user wear taperecorders to ensure better possibilities of verifying the communication and thinking aloud processes relating to each subject. Furthermore, it was very proper to attach an observer to each subject which means that even eye-contact between each of the participants and the shelves/documents

may be noted.

In these experiments the information need situation was incorporated in the user's instruction in such a way that the user was told to ask questions within a field of interest and to which he was not able to provide adequate answers himself. This may differ from some performance tests, where user needs are formalized in test questions. To gain information about the interaction between the user and the document collection/the classification scheme used in public libraries, the user was thinking aloud during his own search. Finding no relevant material he then verbalized his information need to the librarian.

The five users participating in the negotiation experiments were technicians and technical school teachers (4) and a college student 17 years old (UN 2).

Communication and searches resulting from the following subject enquiries were taped and observations made:

UN 1 - Boolean algebra (applied to the design of computer circuits)

UN 2 - Materials and cources concerning the Nonagression Pact between Germany and the USSR

UN 3 - The influence of hunting on Danish bird life from the point of view of ecology

UN 4 - Problems in converting the MKSA-system to the CGS-system in terms of electrical parameters (finished without negotiation)

UN 5 - Problems in computer programming - what is the ECMA-code?

UN 6 - Why do my home-grown celeriacs have a long stalk and no root? (finished without negotiation)

53

UN 7 - (the same user as UN 6)
What does HO on model trains stand for?

TRANSCRIPTION AND PREPARATION OF PROTOCOLS

Preparation of the protocols implies a precise transcription of the tape, timing and marking of pauses down to 1 sec., incorporation of remarks in the protocols concerning the behaviour of the subjects, notes concerning the materials involved, the shelf arrangement of the library, and other important matters.

As a simple introspection, the self-confrontation occurring in the experimental situation obviously shows that such thought processes exist that are not verbalised and thus normally not fixed on tape and in the protocol. But this introspection does not explain the many pauses which we have registered in the protocols.

The pauses are common in the following two situations:

a. when the S's look for a book on a shelf or in the stocks

b. when the S's scan an index, a catalogue etc.

On the basis of the human information processing model of the cognitive processes (fig. 2) it is presumed that information processing takes place in the short-term-memory, which has a limited capacity. This capacity has to be exploited in the search process as well as in the thinking aloud activity at the same time. Hence, it is evident to suppose that working procedures involving a high degree of information processing take place on behalf of the thinking aloud activity. We assume that we are facing the problem of parallell processing which means that thoughts concerning for example the scanning of an index are not verbalized.

subject	Text 1, serie 1, sp. 1 recording time/sec	pause time/sec	P/O %	no. of pauses	average sec/pause	Text 1, serie 2, sp. 1 recording time/sec	pause time/sec	P/O %	no. of pauses	average sec/pause
o1/1/U	1414	1114	75	229	4,9	1166	665	57	204	3,3
o1/2/U	925	510	55	157	3,3	687	388	56	130	3,0
o1/3/L	+	+	+	+	+	2730	1327	49	527	2,5
o1/4/U	892	663	74	86	7,6	1804	964	53	343	2,8
o2/1/U	1040	603	58	169	3,6	793	510	64	102	5,0
o5/1/UL	314	202	64	41	4,9	2015	1209	60	235	5,2
o6/1/U	1485	622	42	218	2,9	1530	614	40	265	2,3
o7/1/L	190	123	65	24	5,1	+	+	+	+	+
o9/1/L	440	290	66	55	5,3	2397	1880	78	195	9,6
1o/1/UL	ikke optalt					ikke optalt				
11/1/UL	ikke optalt					ikke optalt				
12/1/U	ikke optalt					ikke optalt				
12/2/U	ikke optalt					ikke optalt				

Table 1: disply of time of pauses

no. of sec.	o1/1U/sp.1 A	T	A%	T%	o1/2/U sp.1 A	T	A%	T%	o1/4/U sp.1 A	T	A%	T%	o1/4/U sp.2 A	T	A%	T%	o2/1/U sp.2 A	T	A%	T%
1	62	62	27,3	5,6	66	66	43,3	13,3	42	42	48,3	6,3	141	141	41,1	14,6	47	47	46,1	9,2
2	4o	8o	17,6	7,2	29	58	18,5	11,4	16	32	18,4	4,8	77	154	22,4	16,o	13	26	12,7	5,1
3	24	72	10,6	6,5	16	48	1o,2	9,4	6	18	6,9	2,7	44	1 32	12,8	13,7	8	24	7,8	4,7
4	17	68	7,5	6,2	1o	4o	6,4	7,8	3	12	3,4	1,8	22	88	6,4	9,1	3	12	2,9	2,4
5	18	9o	7,9	8,1	8	4o	5,1	7,8	3	15	3,4	2,3	21	1o5	6,1	1o,9	2	1o	2,o	2,o
6	11	66	4,8	6,o	9	54	5,7	1o,6	1	6	1,1	o,9	11	66	3,2	6,9	2	12	2,o	2,4
7	13	91	5,7	8,2	4	28	2,5	5,5	2	14	2,3	2,1	4	28	1,2	2,9	3	21	2,9	4,1
8	8	64	3,5	5,8	4	32	2,5	6,3					5	4o	1,5	4,1	2	16	2,o	3,1
9	6	54	2,6	4,9	1	9	o,6	1,8					5	45	1,5	4,7	5	45	4,9	8,8
1o	6	6o	2,6	5,4	2	2o	1,3	3,9	1	1o	1,1	1,5	4	4o	1,2	4,1	3	3o	2,9	5,9
11	4	44	1,8	4,o									4	44	1,2	4,6	3	33	2,9	6,5
12	2	24	o,9	2,2	2	24	1,3	4,7	1	12	1,1	1,8	1	12	o,3	1,2	1	12	1,o	2,4
13	1	13	0,4	1,2					1	13	1,1	2,o								
14					1	14	o,6	2,7												
15	3	45	1,3	4,1	1	15	o,6	2,9	1	15	1,1	2,3								
16	2	32	o,9	2,9													1	16	1,o	3,1
17	2	34	o,9	3,1																
18																	1	18	1,o	3,5
19													1	19	o,3	2,o				
2o	4	8o	1,8	7,2	1	2o	o,6	3,9									2	4o	2,o	7,8
21																	2	42	2,o	8,2
22	1	22	o,4	2,o																
23									1	23	1,1	3,5								
24													1	24	o,3	2,5	2	48	2,o	9,4
25																				
26									1	26	1,1	3,9					1	26	1,o	5,1
27																				
28	1	28	0,4	2,5					1	28	1,1	4,2								
29	1	29	o,4	2,6					1	29	1,1	4,4								
3o									1	3o	1,1	4,5								
32																	1	32	1,o	6,3
4o					1	4o	o,6	7,8												
47	1	47	o,4	4,3																
55									1	55	1,1	8,3								
62									1	62	1,1	9,4								
63									1	63	1,1	9,5								
74									1	74	1,1	11,2								
84									1	84	1,1	12,7								
ialt	227	11o5	99,7	1oo	157	51o	99,8	99,8	87	663	1oo,1	1oo,1	343	964	99,8	1oo	1o2	51o	1oo,1	1oo

Table 2: distribution of pauses in relation to the duration of pauses.

A: no. of pauses, T: time, A%: no. of pauses in rel. to total no. of pauses, T%: time in % in rel. to total time of pauses.

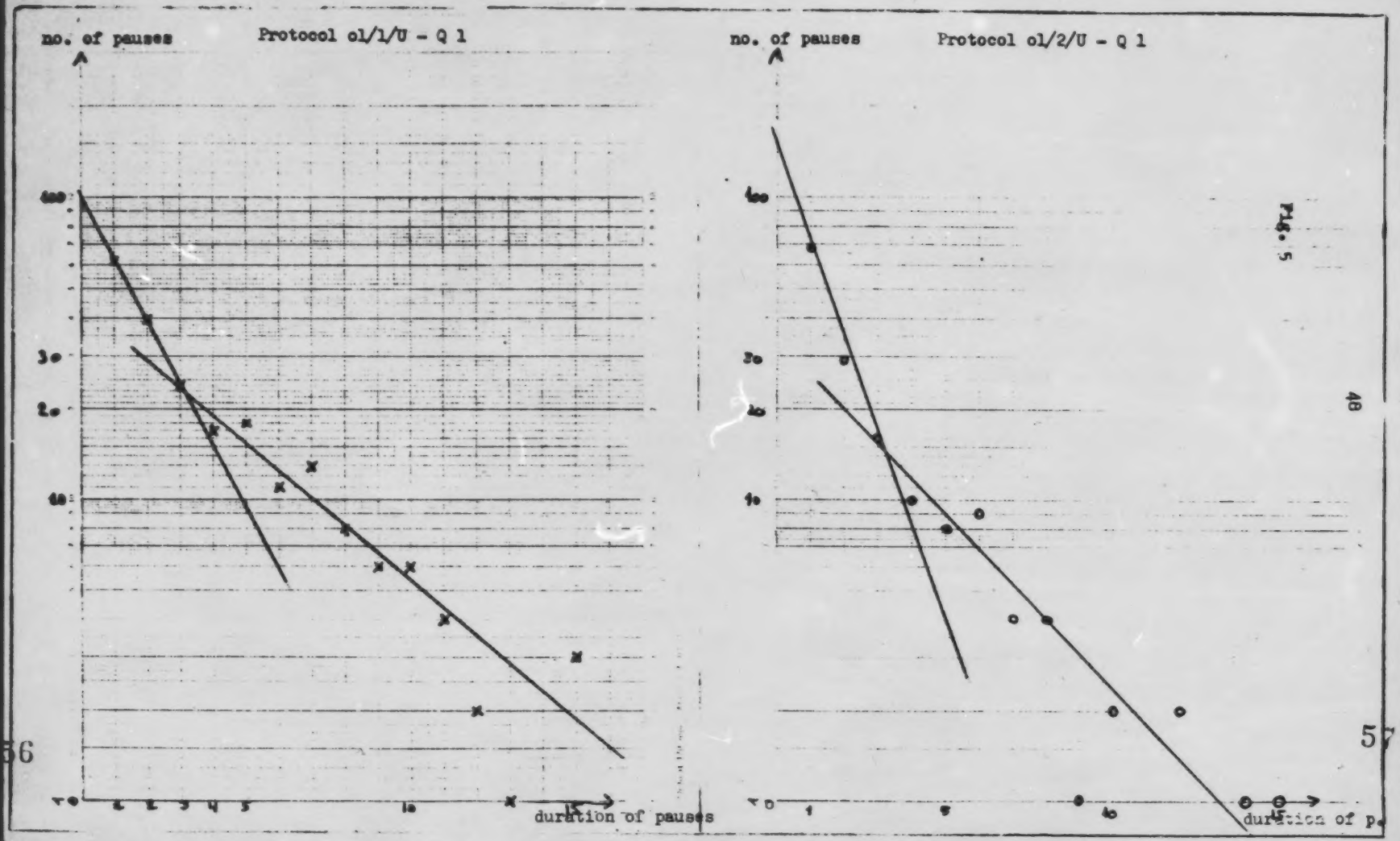

no. of pauses
Protocol o1/1/U - Q 1
duration of pauses
no. of pauses
Protocol o1/2/U - Q 1
duration of p

Fig. 5

We have made a statistical approach to the pauses in some of the recordings. The figures appear in table 1.

It must be mentioned that the duration of the recordings range from 190 sec. to 2730 sec., and that the duration of pauses as a whole cover over 50% of the recorded time. For some of the recordings we have calculated a distribution of the duration of pauses. According to expectations we observe a skewed distribution, table 2.

In table 2 we show the number of pauses in relation to the duration of pauses in a graphic delineation on semilogarithmic paper for two of the recordings, fig. 5. From the total material it is obvious that it is impossible to draw only one straight line, but rather two which intersect. Thus, the measurements seem to be distributed following two skewed distributions.

This may indicate that pauses of a duration ranging from 1 to app. 5 sec. (the one straight line) represent other mental processes within the S's than pauses of a duration of more than 6 sec. (the other straight line).

It may be mentioned, that the unreliability of the longer pauses is rather high because of the limited number of such pauses.

V ANALYSIS METHODS.

We consider the verbal protocol analysis to be the preparation of the content of the protocols. Dependent on the problems, we intended to investigate, we have employed different analysis methods. The preparation has been carried out at different levels ranging from "common sense" assessments to formulation of detailed hypotheses concerning mental processes.

The literature on protocol analyses mostly deals with analysis

of protocols derived from the solving of for example mathematical and chessplaying problems in which the problem dimension is more limited, and may be structured more easily than in our more complex problem solving situation. Hence, in many cases, we have been forced to develop our own methods.

When investigating a professional working situation, and considering it as a problem solving situation, it is necessary to take into account and understand the working routines of the profession. This means to isolate recurrent patterns of routines which occur in the protocols, and to discover and understand their function in the working process.

This has been done in an outline of the protocols, by discussions with the S's and on the basis of our own library training and experience.

As a tool to discover and analyse search possibilities, possible aspects of topics and subject relations we use a heuristic association model developed in connection with the project (52, 53).

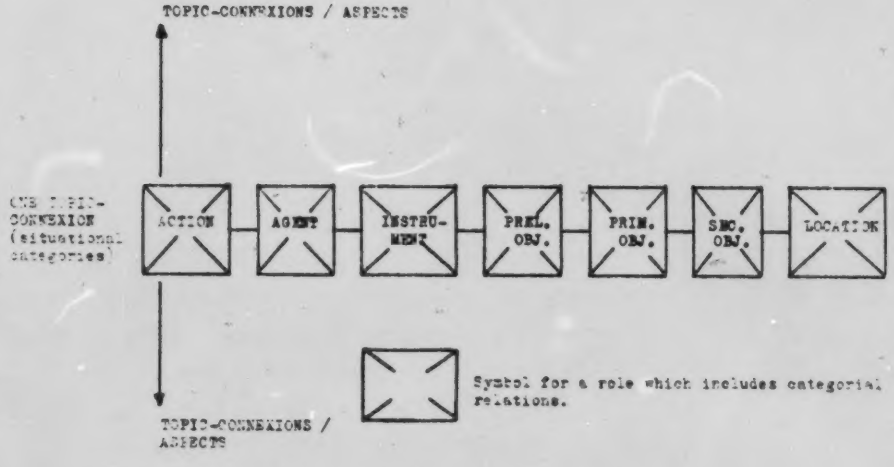


Fig. 6

The model is created to structure associational relations between related concepts. It is based on a combination of situational and categorial relations.

The situational relations are based on the relations between certain roles in a context expressing a dynamic process (Fillmore, Coates, Ranganathan). The roles are:

Action, Agent, Instrument, Preliminary object, Primary object, Secondary object, and Location.

Primary object is the result of the action taking place.
Preliminary object is the origin (material/non-material) of the primary object.
Secondary object is the reason (subjective and objective) for the action taking place.
Location includes both time and space.

A certain concept placed into one of these roles may have situational relations to other concepts which play the other roles in a certain process/topic-connexion. Example from one of the testquestions: "Technical draughtsmen" may be Agents in the process: "technical drawing" - Primary object is "technical drawings". This "Technical drawing" connexion is in some classification systems located to the 700... or the 600. Thus, each dynamic process as a whole constitutes one individual aspect of a topic. "Technical draughtsmen" may also play a Primary object role. They now form part of a topic-connexion in which for example "engineers" (Agents) are teaching (Action) "students" (preliminary object) to be "Technical draughtsmen" (Primary object) for example in "technical schools" (location). This aspect of "draughtsmen" is educational, located to the 300 and as a special subject field to the 600/700. In addition to the situational relations each concept has categorial relations to hierarchical and other concept-categories such as: Generic, part-whole, identity and likeness, property, quasi-generic... etc. Examples of some of these relations are outlined in fig. 6A.

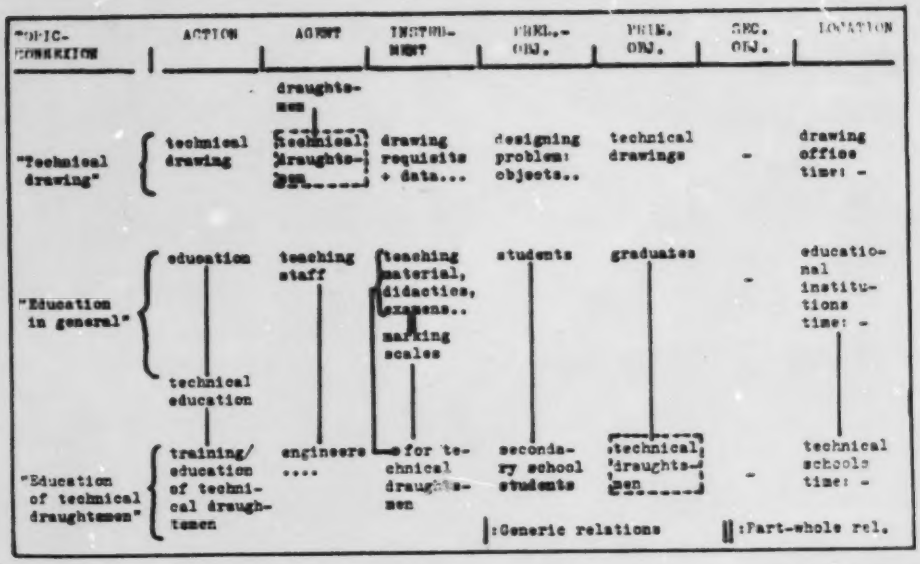


Fig. 6A. Extract of Association model in search possibility analysis.

Furthermore, this model may be used by the intermediary as a tool in the information transfer process. The intermediary is able to use it as an underlying structure or map in the communication process. By the means of a concious use of the topic relation possibilities the intermediary may develop related concepts/aspects concerning a user need.

With regard to the analysis process the model is used as a means to attain to a general view of the real search and solving possibilities (fig. 6A). Having attained to this view the analysis of the protocols is carried out at a macro and a micro level.

THE MACRO ANALYSIS

This consists of a functional and structural division of the protocols into activity elements. This means that we are able to:

a: determine exactly which search and solving possibilities that are used by the individual S's in each protocol, in which succession and by means of which working routines.

b: compare the successions across S's for each test-question to discover patterns in the S's' use of search and solving possibilities and in the mutual succession of these, fig. 7 + 7A.

When studying the results of this macro level analysis one may ask questions such as:

- why do the S's employ the different search possibilities, i.e. classes of classifications systems, documents, tools etc.?
- which search terms or concepts are used in different search possibilities, and from where do they originate, i.e. which kind of knowledge structures are involved?
- how is the connection between the different search possibilities determined? (table 3 + 3A).

THE MICRO ANALYSIS

When answering these questions of cause and effect we pass on to one kind of micro analysis, which implies an examination of the content of the protocols selectively, i.e. especially concerning points of search possibility decision by the means of another kind of micro analysis concentrated on the detailed display of all the thought processes and activities in each protocol. This means to identify in detail the relations between activities, processing of thoughts and information perceived by the S's throughout the problem solving process.

For this purpose each protocol is divided into statements,

defined as the smallest limited utterances or actions which make sense. An example of the division of a protocol into statements is shown on page 56.

It was obvious from the beginning of the project that a detailed analysis method was necessary if we wanted to carry out an in-depth microanalysis.

During the work with the experimental design two members of our team worked especially on the development of a coding scheme. The first coding language was based on the pilot investigations, and was mainly applicable to topic relations. However, it appeared that the training recordings included less pure topic relations than expected, but they were very rich on reflections and intentions with regard to actions. On these lines Thomas Johansen developed a much more sophisticated analysis method (54) which up to now generally has formed the basis of our coding scheme. Søren Kaae then drew up the final scheme based partly on the detailed method developed by Johansen and partly on the content of the protocols, produced from training and experimental recordings (55). This coding scheme is delineated with examples and rules for application of the different codes, etc. The scheme was then tested by the other members of the team and checked against selected protocols to see if the codes were consistent.

Finally, the coding scheme appeared to be applicable to a very great extent. Unfortunately, lack of time and money have prevented us from coding all the experimental recordings completely.

The statements which the protocols are divided into, are classified according to 6 notations out of which a highly complex coding language is developed. The notations are based on the following principles:

a: distinction between utterances concerning thoughts (T-codes) and concrete actions (A-codes).

b: distinction between topic to topic relations/ associations undertaken by the S's on the basis of
- conceptual state of knowledge of the S's
- information input from the environment (user, need, tools, texts, etc.)

c: the use of the environment by each S's is considered an interaction (acceptance/rejection of index or titles).

Consequently, the main content of the 6 notations are:

I: topic to topic relations resulting from mental processing of actual conceptual state of knowledge of the S's (T03 - T18) (CS, L, fig. 4)

II: Topic to document/group of document relation derived from mental processing involving conceptual state of knowledge and state of knowledge of document/document representation (T20 - T49) (CS,L ↔ S,L(D/Dr), fig. 4)

III: the different material units with which the S's may be confronted (D → Dr, fig. 4) (ex: shelf=L, doc.=D, index in doc.=RD)

IV the S's reaction in relation to the perceived information (code 0 - 8) (ex: acceptance of data = 6, rejection of material = 5, perceived and immediately rejected information = 3) (QU and D → Dr. in relation to CS,L, fig. 4)

V: The S's possible actions (ex: taking doc. from shelf = AD, looking up in an index in doc = ARD)

VI: other elements (T01/T02, T50-T99) (ex: T89: S states that he has found the solution to the problem. T90: statements not categorized).

Observation remarks ():

o5/1/UL/761p2o - rev. 1 , inst.: SK

(1)-begins at a reference desk

(2)-walks to doc. in ref. room (there are 2 E.K.'s: a: one for ref. use b: one for lending S use first a) reach E.K. and pick up the index card.

(2a)-S look up technical draughtsmen in index.

(3)-look through the EK without finding the card

(4)-look up in EK(b)

(5)-look through EK 02.

(6)-pick up the card concerning tech. draughtsmen

(7)-S read/scan the text

(8)-S puts the card away 03.

(9)-takes doc. from shelf, looks up in beginning of doc. in which there is a: subject index and b: chronological index

(10)-looks through subject index to find training, which is not an entry in index

(10a)-look through the chronological index and look up on 23. of august

(11)- expressed with a searching voice 04.

(12)-look up the text in doc.

(13)-puts doc. on its place

---

a statement: |1.....|2

.. : 2 sec. pause

/4/: 4 " "

Q 1: Which marking scale is used in the assessment of (technical) draughtsmen?

|1 (1)"Which marking scale is used in the assessment of technical draughtsmen" /4/ yes /3/ then I in the first place rather have to find out which . training the draughtsmen get, ehh which high school they consult, I don't know that immediately . and ehh that I think I will look up in Erhvervskartoteket* /12 (2)/ in .. Erhvervskartotekets' . index .. one can look up on (2a) . technical draughtsmen /26 (3)/ but that article is not on its place ... (4) I try the other Erhvervskartotek /24 (5)/ yes that was really embarrassing that .there is a mess in the Erhvervskartotek ... (3) there it was (6) .. "technical draughtsmen" /11(7)/ "the theoretical training takes place in the daytime, in evenings or as correspondance . course" . "the training in the daytime and in evenings takes place on a technical school" /10/ and some institutions .. governemental, municipal and private have prepared their own training programmes /4/ and there exists a range of different courses in technical drawing . "howe/however the is no specific demands as to previous education" . and certain training centers are controlled by the government ... tjahh /10/ there is a reference to a Government notice from the educational ministry dated the 23 of august 1968 /5/ and /4/ it is possible that in this there is mentioned something about/about which marking scale which is used, if it is the 13-scale or . another scale /12 (8)/ so .. I'll try to look into .. Lovtidende* from 1968 /15(9)/ and eehh what is it called .. training /7(10)(10a)/ no, I think I rather use the chronological index .

23. of august (11) . "Governmental notice concerning training of technical draughtsmen" page 1043 /18(12)/ and there is written that they use a marking scale which begins with extremely fine giving 7 points and then down to poor giving ÷5 points /4/ and eehh . assuming the Erhvervskartotek from july 1974 .. eehh still is current /4/ and correct in it's reference then the question thereby should been answered (13) |

* Erhvervskartoteket= an archive with information about different professions.

* Lovtidende = annual collection of government laws and notices.

Coding of protocol o5/1/UL/761o2o

st. nr	Type T	Type A	
1	T01-C(st.7)		reading and
2	T15		consideration of query
3	T15		
4	T20		relation to special doc.
5		WLrr	walks in reference room
6		ADO	routine 1 : looking up in a special doc./interrupted
7	RD2(st.1; 14)		
8	RD8		
9		ATD2	
10	D7 +		
11		AD5	
12		ADO+(s.s.st.6)	routine 1 repeated
13	DO		
14		ATD2(s.s.st.9)	
15	T90		
16	D8		
17	TDC	reads doc	
18	TDC		
19	TDC		
20	TDC		
21	TDC		
22	TDC		
23	TD6 (st.27;)		accept+assimilation of informations from text
24	T03		considerations conc. use of inf.
25	T03		
26		AD5	
27	ID2(st.23)		concideration of new doc./intention of action
28		AD2	takes doc.
29	RDO/T03		uses actual generated search term
30	RD5+		S reject the index
31	RD2+(st.23;)	routi. 1	another index, new search term, assimilated in st. 23
32	RD8 search term found		
33		ATD2	looking up in text
34	TD6		accept+assimilation of new inf.
35	T03/T89+		relating inf. to query/accept
36		AD5	puts doc. back

DIAGRAM DISPLAY of PROTOCOL o5/1/UL/761o2o - ser. 2, Q 1

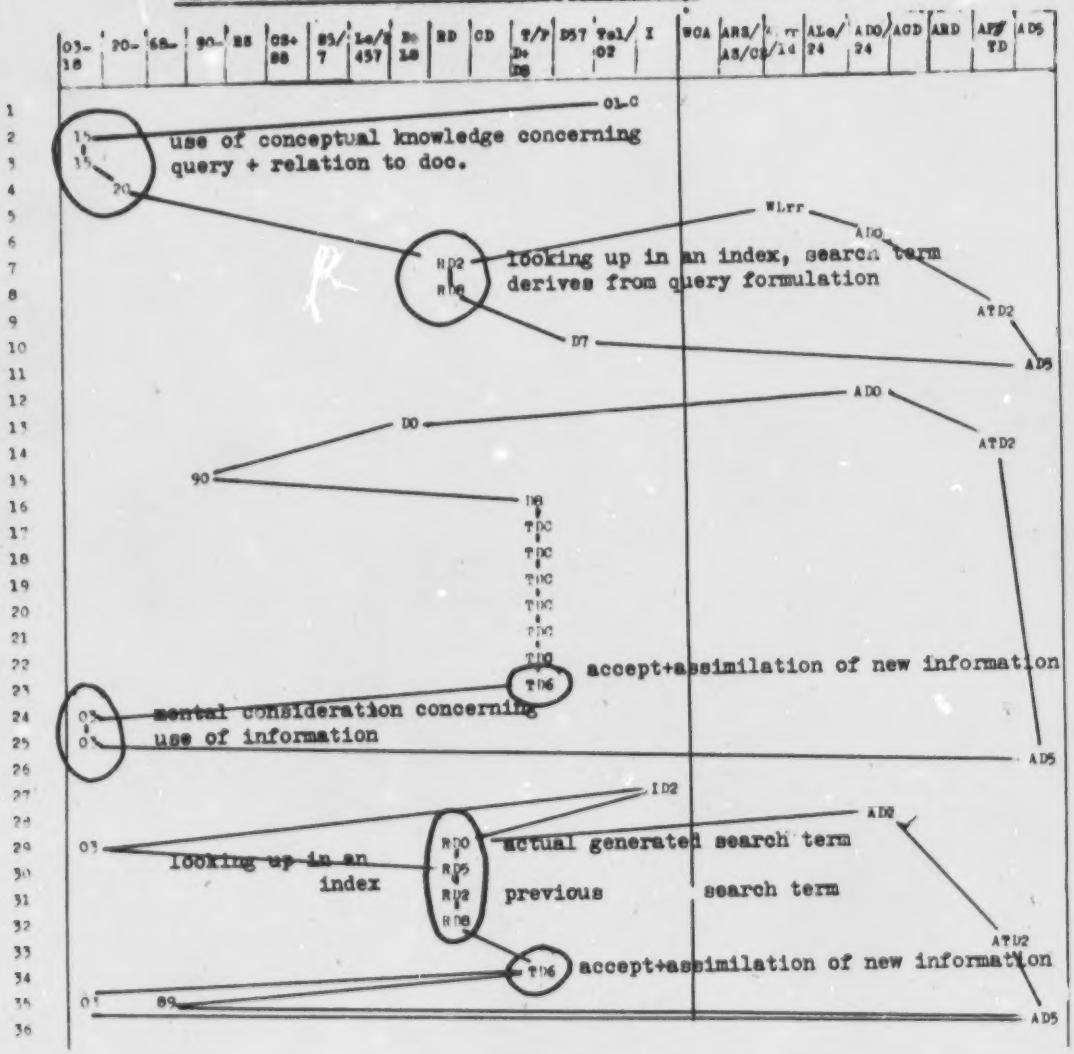

use of conceptual knowledge concerning query + relation to doc.
looking up in an index, search term derives from query formulation
accept+assimilation of new information
mental consideration concerning use of information
looking up in an index
actual generated search term
previous search term
accept+assimilation of new information

Fig. 4

When combining the codes from the different notations it is possible to transcribe the protocols into the code language and to reproduce them in a graphic form (page 57 and 58).

The graphic representation gives a detailed overview of the mutual connection and inter-dependence of the different thoughts and working routines.

Although these macro and micro analysis methods are very sufficient to investigate both search processes generated by written queries and user-intermediary interaction and search, there has been a need for a supplementary social-psychological and psycho-linguistic approach to the interaction analysis. Lise Anker-Møller et al. (56) have developed an analysis method in connection with the project with the specific aim to identify basic communication as well as behavioural phenomena which may affect the search process.

The method is based partly on studies concerning the reference interview (57) for non-fiction as well as fiction (58), partly on investigations and theories concerning interpersonal communication and behaviour (59).

Hutchinson has made a distinction between 3 kinds of information which is transferred during an interpersonal communication sequence (60):

A: information which is exchanged between the communication partners being able to "cooperate" and organize the dialogue

B: behavioural information which serves to inform the partners of their biological, psychological and sociological characteristics in the actual situation (indexical information)

C: information concerning adequate and factual meaning of the communication.

Hence, the method of interactive analysis deals with 3 analysis levels:

1: the sequential level which refers to A. At this level the analysis is based on divion of the protocol into exchanges of words/dialogue. These sequences are analysed briefly, drawing upon theories from ethnomethodology, and deal with phenomena as insertions, function as leader or administrator of the communication, the function of pauses, the function of "eehhh" as a means to keep the position in the dialogue and open/closed/indirect questions.

2: the interpersonal level which refers to B. This analysis level elaborates level 1 and explains phenomena such as roles, attitudes, status, expectations, behavioural relations, presuppositions etc.

3: the substantial level which refers to C and may be regarded as similar to the micro/macro methodology mentioned above.

VI ANALYSIS AND RESULTS

The presentation of the results can be structured/classified in accordance with 3 areas of interest:

1. the librarians' separate search (on the basis of a written query)

2. the user's separate search (on the basis of his/her own need formulation)

3. the negotiation process between user and librarian.

1. THE LIBRARIAN'S SEPARATE SEARCH

1 A. *General factors derived from the daily work conditions, the design of the library, etc.*

When collecting and processing the material it is important to be aware of the fact that general factors, such as working conditions, have some implications for the S's' behaviour - in the experimental situation as well.

Below we will mention some examples:

a) Generally, the librarians have got an impression of the time limits allowed for the handling of an inquiry, before it is finished or possibly referred to another department/institution. This time limit varies from one librarian to another and differs from lending department to reference unit. The time factor causes a general pressure which is accumulated during the handling of the inquiry/literature search.

The division of labour between lending department and reference unit have various effects:

b) A librarian who is used to work in one of these departments will, when handling an inquiry estimate whether it is to be dealt with by one department or the other. Also, distances to stackrooms for instance have some influence. This has also been true of individual S's in connection with our queries.

c) In many libraries the reading room is often the place where inquiries that have proved insoluble in the lending department are treated. By routine it is assumed that a lot of material has been examined in advance, before an inquiry ends up at the reference librarian. The reading room

staff tends to be much more tool and source-oriented. The lending department, however, seems to be more oriented towards monographs that might be taken home by a borrower.

d) The libraries' aids play a part too. In connection with for instance topic-related searches it will be of great importance whether there are e.g. 100 entries under a specific heading in the catalogue or only 10.

1 B. *Macro level*

From training programme question QA - the query concerning the degree-day-figure - we derived the following indications regarding general problems in the search process.

As expected the S's immediately tried to provide titles in the field of meteorology as a first attempt. Being unsuccessful the S's repeated their procedures and did not produce lines of thought containing topic relations as we expected. The S's seemed very preoccupied with following search directions generated from the words mentioned in the question, mostly the word "weather".

In one case private experience from the episodic memory turned up immediately in the beginning of the protocol ("it has something to do with my oil burner at home"). This was forgotten in favour of meteorology until late in the protocol.

Some S's attempted to break down the composite word degree-day-figure and trace degree, which actually led to a homonym problem (degree for latitude). Weak knowledge structure of the topic seems to be the reason.

We have paid attention to the function of mental pictures or images and the S's were asked to report such phenomena. Mental pictures may be present in memory recall procedures

and associations (61). The mental pictures may originate from private experience, spatial arrangement of books in the library, the structure of the classification system or otherwise.

However, the macro analysis as well as the self-confrontation resulted in very few mental pictures during the search.

Comments on search possibilities in the experimental recordings

Q1: "Which marking scale is used in the assessment of (technical) draughtsmen?"

The following areas of search interest may immediately be indicated on the basis of the query formulation - see also fig. 6A:

- a technical drawing area produced by the concept "technical draughtsmen" in fig. 7 possibility B1.

- a general educational area derived from "marking scale" and "assessment", in fig. 7 possibility A1.

The combination of concepts within the question as a whole leads to a more specific topic area.

- training of technical draughtsmen, in fig. 7 possibility B1 which have to be connected to one of the two areas mentioned.

According to the general rules of the Danish public library classification scheme (DK-5) literature on training within special subject fields is grouped under each subject field i.e. in this case in the DC class representing technical drawing.

However, training in this subject field as well as in other technical fields is dealt with in a main class covering educational training in applied science in general according to a special rule - in fig. 7 possibility B2.

This fact may lead to additional problems, which involve the S's knowledge structures as regards document representation (D/Dr. - fig. 4).

To find an answer to the query it is necessary to identify a governmental recommendation with regard to training of technical draughtsmen.

This leads to the area of law documents with special regard to different training and educational regulations - in fig. 7 possibility A2.

This area represents problems which affect the S's conceptual knowledge structures (CS) concerning administration of the Danish society.

In addition to these areas of search interests one may mention a search possibility mainly derived from a special type of documents:

- Locational guidance, in fig. 7 possibility C.

In fig. 7 we have summarized the result of the successive division of each protocol into the actual realized search possibilities and the applied solving possibilities concerning test question 1

All search possibilities are tried during the first action with possibility C as the most significant one. This is remarkable taking into account that this possibility is not directly depending on query formulated concepts, but derives from knowledge of a special type of documents.

Search mode	fpb (S)	Action no. + search possibility 1 2 3 4 5 6 7 8 9 1: 11	solving possibility
0	11/1/UL	C - A2 (HLJB, + henv.)	+ sml.b
0	05/1/UL	C - A2 (HK, + henv.)	+ Lovt.
0	09/1/L	C - A2 (HK, + henv.)	+ Lovt.
0	12/2/U	C - B1 - C - A2 (HK, + henv.)	+ sml.b
P	12/1/U	C - $B1^{S}$ - $B2^{S}$ - C - B2 (HK, + henv.)	+
SP	01/2/U	C - A1 - C - D - B1 - D - A2 (HK, + henv. i HK)	+ Lovt.
P	07/1/L	A2	+ Krogh
SP	01/4/U	$A1^{S}$ - C - B2 - A2	+ Krogh
P	10/1/UL	A1 - C - A1 - $B1^{S}$ - B2 - B1 - A2	+ Krogh
P	02/1/U	$B2^{S}$ - C - B2 - C - A2	+ Krogh
P	06/1/U	$B1^{S}$ - $B2^{S}$ - C - B2 - C - B2 - A2	+ Krogh
P	01/1/U	B1 - C - B2 - C - A2 - B2 - C - B1 - $A1^{S}$ - D - A2	+

S - the action of the S is restricted to a reference in the catalogue or the subject index of the classification system

sml.b + lovt. - this documents may be characterized as general law documents

Krogh - this document contains only laws and government notices concerning training and education.

Search mode: see chapt. 1 C.

Explanation to the search possibilities:

A1: poss. concerning examinations, marking scales and training/education in general (pedagogical topics)

A2: poss. concerning different types of law documents

B1: poss. concerning the specific training of technical draughtsmen

B2: poss. concerning technical training/education in general

C : poss. concerning locational guidance

D : other possibilities such as asking colleagues.

HLJB: Reference tool with information about different professions

HK: An archive with information about different professions

henv: reference

Fig. 7

Thus, the fig. indicates a division of the S's into 2 groups:

- one which realizes search possibility C as first action, and which uses solving possibility sml.b/lovt.

- one which uses all the other search possibilities as first action, and ends up with 'Krogh' as solving possibility.

This may indicate a connection between the choice of first action and the applied solving possibility. In relation to the applied solving possibility, there seems to be no connection between this and the working domain of the S's (U,L,UL). But concerning the choice of first action and the total search procedure (succession of routines) there seems to be a relation to the working domain, i.e. reference and reference/lending librarians have very brief search procedures, and the majority of this group starts with search possibility C, followed by A2 or A2 alone. All lending librarians seem to encounter much more difficulty in the search procedure. To investigate this further we have to move to the micro level analysis, see 1 C.

A statistical grouping of the successions of search possibilities, reveals groupings of couples, out of which some occur more frequently than others (table 3). The interesting connections are:
C-B2(6), C-B1(3), C-A2(6), B2-C(7), B1-B2(3) and A1-C(3).
The micro analysis of this is briefly mentioned in 1C.

Furthermore, the grouping of successions shows only few larger groupings than couples, however, they don't have any substantial similarity.

Q2: "Does Danish snaps freeze in a freezer? The freezing point of Danish snaps?"

The following areas of search interest may immediately be indicated from the query formulation:
- a physical/chemical area, indicated by the concept "freezing point", in fig. 7A possibility 1.

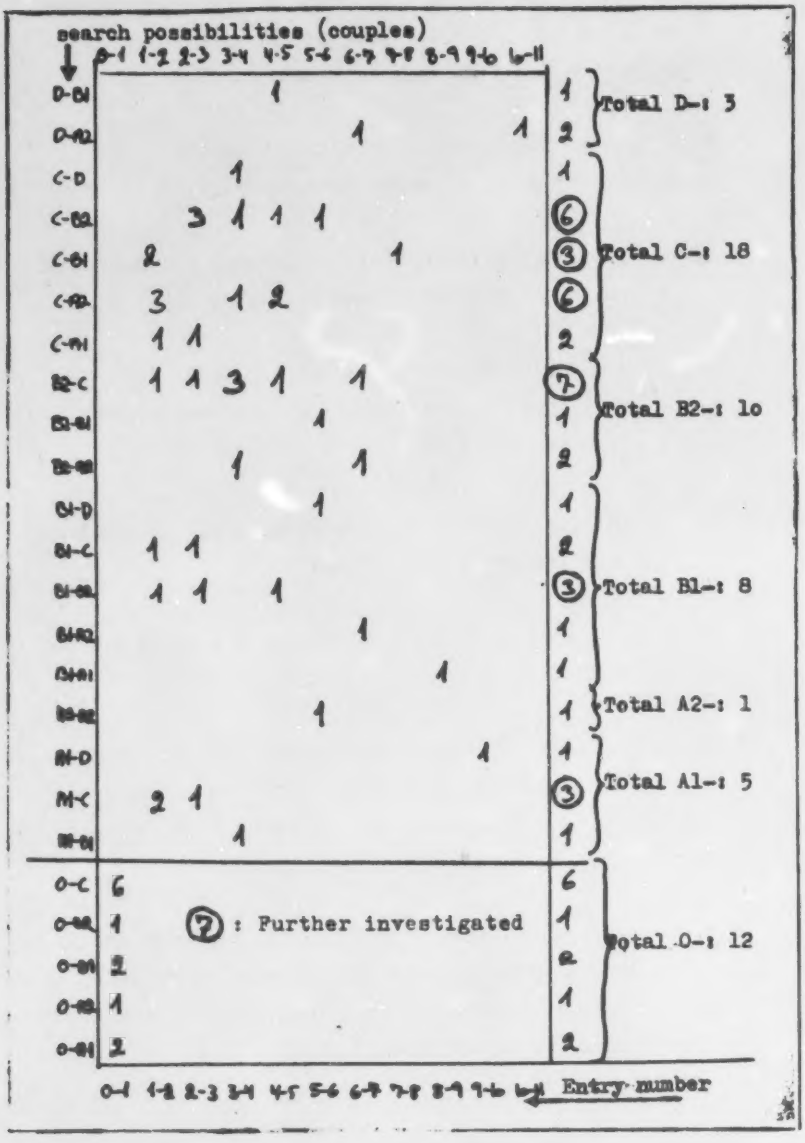

search possibilities (couples)
0-1 1-2 2-3 3-4 4-5 5-6 6-7 7-8 8-9 9-10 10-11
D-B1
D-B2
C-D
C-B2
C-B1
C-A2
C-A1
B2-C
B2-B1
B2-A2
B1-D
B1-C
B1-B2
B1-A1
B1-A2
B2-A2
A1-D
A1-C
A1-B1
0-C
0-B2
0-B1
0-A2
0-A1
7 : Further investigated
Total D-: 3
Total C-: 18
Total B2-: 10
Total B1-: 8
Total A2-: 1
Total A1-: 5
Total O-: 12
Entry number

Table 3

This area will give the S's additional problems, because snaps is a mixture of ethanol, water and different flavourings, which means that it can't be found directly as snaps.
- the snaps/alcohol area, the special product and it's production, in fig. 7A possibility 3.

From this another broader area can be defined:
- the area of goods or provisions, in fig. 7A possibility 2.

In the query there is indicated a process or instrumental area
- the area of deep freezer/deep freezing.

To these areas of interest one has to add
- the general search possibility in the encyclopedias, in fig. 7A possibility 5.

Out of the search possibilities in Q2 there is a chance to find a solution in poss. 1 and 3.

In poss. 1 one may find a solution in "Handbook of Chemistry and Physics".

In poss. 3 we have only found one book out of plenty which contains an answer to the query. There are no direct entries pertaining to this answer, and it depends on a chance whether the S's find it or not.

The other possibilities do not lead to a direct answer, but may in general provide relevant information or data, either concerning the temperature in a deep freezer or different properties of snaps or alcohol, which can be useful in the further search.

In fig. 7A we have reproduced the result of the successive division of each protocol into actual conducted search

Search mode	Sub-jects	Action no. + search possibility 1 2 3 4 5 6 7 8 9 10 11 12	Solving possibility
P	o1/1/U	1 - 4 - 1 - 6 - 1	(+)
SP	o1/2/U	1 - 2 - 5 - 3	+
O	o2/1/U	1	(+)
O	11/1/UL	1 - 3 - 4(- 2)	+
O	o1/3/L	2 - 3 - 2 - 1 - 5 - 2 - 4 - 2 - 1 - 2 - 1	+
SP	o5/1/UL	2 - 3 - 2 - 1 - 4(- 2 - 1)	(+)
SP	o9/1/L	2 - 6 - 2 - 1 - 6 - 1 - 5	(+)
P	12/2/U	4 - 2 - 3 - 1 - 6 - 5 - 4 - 2 - 3 - 4 - 1 - 3	+
P	o6/1/U	4 - 1 - 3 - 1	+
P	o1/4/U	3 - 4 - 2 - 1 - 4 - 1 - 2 - 1 - 5 - 3* - 2 - 3	+
P	1o/1/UL	5 - 1 - 5 - 3 - 2 - 5 - 1 - 6 - 3 - 5 - 6	+

* : The action of the S is restricted to a reference in the catalogue or in the subject index of the classification system.

(+): The S ends up with a solution which is not acceptable.

Search mode : See chapt. 1 C.

Explanation to the search possibilities:

1 = Possibility concerning physics/chemistry
2 = " " snaps as a provision
3 = " " alcoholic beverages
4 = " " deep freezers / deep freezing
5 = " " encyclopaedias
6 = Other possibilities, such as asking colleagues

Fig. 7A

possibilities and the applied solving possibilities relating to test question 2.

All search possibilities have been used in the first action with possibility 1 and 2 as the most significant ones.

It can be pointed out that in general possibility 1 (physics/ chemistry) is a very difficult search possibility, because

it implies a certain degree of knowledge of the topic in order to cope with physical/chemical terminology problems in terms of everyday concepts versus scientific concepts. If the searcher imagines to find a table of freezing points of different compounds from everyday life, this imagination will be inconsistant with the characteristics of the literature in the field.

From fig. 7A it may be supposed, that there in certain cases is a connection between 1. action and the working domain, if one looks at the S's who rely on possibility 2 as 1. action. To investigate this indication, we have to move to micro level analysis, see 1 C.

Number of couples of applied search possibilities					
From/to	No.	From/to	No.	From/to	No.
1 - 2	3 §	2 - 1	6 §	3 - 1	2
1 - 3	3 §	2 - 3	6 §	3 - 2	4 §
1 - 4	2	2 - 4	1	3 - 4	4 §
1 - 5	4 §	2 - 5	2	3 - 5	1
1 - 6	4 §	2 - 6	1	3 - 6	o
4 - 1	3 §	5 - 1	2	6 - 1	2
4 - 2	4 §	5 - 2	1	6 - 2	1
4 - 3	o	5 - 3	3 §	6 - 3	1
4 - 5	o	5 - 4	1	6 - 4	o
4 - 6	o	5 - 6	1	6 - 5	1
		§: Further investigated			

Table 3A

A statistic grouping of the successions of search possibilities reflects grouping of couples, out of which some occur more frequently than others (table 3A). The interesting connections are:

2-1(6), 2-3(6), 1-5(4), 1-6(4), 3-2(4), 3-4(5), 4-3(4), 1-2(3), 1-3(3), 4-1(3) and 5-3(3). The micro analysis of this is briefly mentioned in 1 C.

Our observations from the division of the protocols into action elements in relation to search poss. in 7 + 7A show that the librarians use different working routines.

The routines can be characterized as follows:

a- from the start of an expedition, the librarian prefers action before mental consideration of the presented problem

b- the actions are directed towards:
- concrete titles on shelves
- classes in the classification scheme, author, class in classification scheme

Mostly the routines are developed on the basis of experience and training, and they are sometimes affected by "least effort" factors. The routines imply that the daily mental work is minimized as far as possible concurrently with a reliance on previous experience in terms of generalized search routines. This is a common and appropriate mechanism.

When mental consideration occurs in the beginning of an expedition it consists of brief formulations on either conceptual knowledge structures, knowledge of tools and documents, or in several cases, private experience as to for instance bottles of snaps in deep freezers. Detailed examinations of the first are described in 1 C in connection with formulation of search problems. The formulation of

private experience concerning freezing is only used indirectly as a support in the search; protocol examples: "Yes, I have experienced that I may freeze snaps..." or "no, it does not freeze". However, it shows that private experience concerning query topics not in general are suppressed in the professional search situation.

1 C. *The micro level*

The routines of action (or mental consideration of action) constitute a stratum which at the same time is covering up and influencing the original mental processes concerning the user need, search procedure etc. and its implications.

To get beyond this stratum it is necessary to study each protocol in detail to analyse:

- which motives the S's have when using the search possibilities,
- how they formulate the search problems,
- which information/data they seek,
- which answers they expect to find,
- which search terms or concepts they use when consulting documents and from where they originate i.e. which kind of knowledge structures are involved,
- how the connection between the different search possibilities is determined.

This examination also provides a solution to the problem of the mentioned connection between the 1. action and the applied solving possibility in Q1. Based on the following arguments there is no logical regularity: if we look at the implementation of C as first action and the relation to the solving possibility in general law documents one may expect that all S's who use C somewhere in the search procedure would end up with the same solving possibility. This is obviously not the case if one looks af fig. 7.

The analysis which implies an examination of the content of the protocols concerning points of search possibility decision shows 2 principal different motives underlying the way of attacking the search problem:

I: at first hand the S's try only to gain information for the purpose of extending their conceptual state of knowledge of the topic. Thus, they are open to new information which possibly later may lead to solutions to the query. This is defined as "open search motive". (Please see note).

II: at the first hand the S's search for a direct solution to the query in shape of a marking scale, or freezing point table, either mentioned by its concept or described. This is the fixed expectation of mode of answer. This means to find the document (title) which includes the answer, and may be defined as "fixed search motive".(Please see note). The S's may mainly rely on their state of knowledge of D/Dr.

Example of motive formulation I:

Example A:

"yes/3/ at first I think I'd better find out which . training the draughtsmen get eehh which high school they consult, I don't know that immediately and eehh I think I will look it up in Erhvervskartoteket" (S 05/1[Q1]).

Note: In a former presentation of the project these two motives have been defined as "Information search" and "Title/fact search". These concepts are rejected because they may lead to homonym problems (2).

Example B:

> "I could think of physical . - chemical . or eehh/no, maybe I should find out how much alcohol there is in . in the snaps and by means of that be able to use . a physical-chemical table to see when different aqueous solutions freeze". (02/1)[q2].

Example of motive formulation II:

Example C:

> "One could try to look up in the Erhvervs-kartotek to see if it contains marking scales" (S 01/1) [q1].

Example D:

> "Yes. One could of course immediately look it up in a book on deep freezing .. and the freezing point of snaps .. eehh . it must be some kind of . eehh what is it called a . book of chemistry". 01/1) [q2].

Thus, the material shows that the working routines mentioned in 1B are employed in different ways according to the above mentioned two motives.

Every single search process is to a great extent dependent on each librarian's expectations concerning a) partly if a document at all may provide an answer, and b) partly in which way the answer may exist. The search process and procedure is consequently dependent on what one may call the degree of openness towards documents and the information they may provide.

The two motives mentioned combined with the degree of openness constitute 3 different modes of search:

I: "Open search"; defined just as motive I combined with a not fixed expectation of mode of answers; "O" in fig. 7 + 7A

II: "Fixed search"; defined just as motive II; "F" in fig. 7 + 7A

III: "Semi-fixed search"; defined just as fixed search combined with a certain degree of openness caused by the search process itself which momentarily leads to a kind of Open search during the process. "SF" in fig. 7 + 7A.

Example on semi-fixed search:

Example E:

"..... That's just to find the freezing point of snaps . ehhm .. and . then I'll go to the reference room and look up in some kind of . ehm . book of chemistry it has to be (walks to ref.room and picks up a table).

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"Handbook in Physics and Chemistry" .. it must be there . let's look .... Oh but ... no. I can't do that because I can't find it under 'snaps'. I can only find .. 'alcohol' .. (scanning the book)

. . . .

no . but first I must have a .. definition of . 'snaps' .. this handbook is not that good anyway". (01/2)[Q2].

If one in solving test question 1 tries to look up in the Erhvervskartotek to find the marking scale directly (motive II), ones attention will be concentrated in this purpose, and other relevant information will be overlooked, for example information about a government recommendation concerning training of technical draughtsmen which is in this case important data.

If one on the contrary bases the search on motive I these relevant data are perceived.

All the S's who base their search on Open Search perceive the relevant data while only 1/7 of the S's who base their search on Fixed & Semifixed Search perceive the data.

This is a general mechanism which has to do with attention and expectation.

In addition, the material reveals that the Fixed Search is adopted most frequently by the lending librarians and that the Open Search is preferred most often by the reference and reference/lending librarians.

Hence, the motives seem to be very much dependent on the S's working domain.

This explains the presumed connection between 1. action, search procedure and working domain, mentioned in 1. B. The fact that the reference and reference/lending librarians have very short search procedures, especially in Q1, seems

to rely on a professional openness which emerges from their daily practicing domain and which involves a deliberate extension of their conceptual state of knowledge.

The S's who base their search on Fixed Search (mostly lending librarians) mainly seem to rely on their state of knowledge of documents/document representation. This may be a result derived from the daily working field, where they interact with users who primarily request documents which are expected to be delivered at once.

When speaking about the formulation of the search problems it is a characteristic feature that S's implementing Open Search either try conciously to describe lack of knowledge, i.e. a concious attempt to build up an appropriate knowledge structure which may serve as a foundation in the further search. See example of Protocol p. 56. Or they make a direct reformulation of the query. See example B.

In the Fixed Search the S's accept the formulation of the query and do not in general formulate specific search problems except a formal analysis of different search possibilities. See example D.

S's implementing the Semi-Fixed Search behave as in the Fixed Search until a certain stage in the search process during which they to some extent review or reformulate parts of the query due to either the expected but missing answer or problems encountered during the search process. Example E.

Search Concepts

When carrying out the analysis of search concepts we have to examine the protocols in terms of points of search possibility decisions and each single action involving use of a search concept. Search concepts are defined as concepts applied to a document by the searcher (librarian) when she is looking up. Search concepts have nothing to do with entry terms which

we regard as concepts occurring within documents or indexes playing the role as entries or headings. We have paid attention to the following 3 different origins of search concepts:

- Concepts originating from the S's conceptual knowledge recalled from memory.
- Concepts originating from the query formulation
- concepts originating from materials, persons etc. consulted by S's during the information search process, i.e. accepted by means of recognition or learning processes.

It has been a characteristic observation that the S's mainly during the first action immediately have used concepts and terms which were written in the query. The analysis across S's shows that 80% of the search concepts applied to first action are the same as those of the query whereas only 20% are recalled from memory. Fig. 8, up.

This result should be expected considering it as a consequence of our statement mentioned in the macro analysis above, that librarians prefer action before mental consideration of the presented problem from the start of an inquiry. The total distribution relating to both queries of search concepts used at each single action across protocols as well as S's, is shown in fig. 8 next page. To the right below is shown the number of individual different search concepts.

The tendency of using concepts from the query formulation is broken up during the progress of the search.

S's basing their search on the Fixed Search mode use to a great extent the concepts written in the query formulation throughout the whole search - fig. 9. Furthermore, this means that the same limited number of concepts are used again and again as search concepts in these search processes - fig. 8, right below. In figures this means that all 5 concepts (fig. 8) have been used at least 67 times (fig. 9). 87

Applied SEARCH CONCEPT: 1st action	QUERY 1 %	QUERY 1 number	QUERY 2 %	QUERY 2 number	TOTAL QUERY 1 & 2 %	TOTAL QUERY 1 & 2 number
RECALLED FROM MEMORY	17	2	18	2	17	4
ORRIGINATED FROM QUERY	83	1o	82	9	83	19
Total all S's	1oo	12	1oo	11	1oo	23

Total number of individual actions of consulting: 264

Total number of individual actions of consulting with KNOWN SEARCH CONCEPT: 189 = 72 %

Applied SEARCH CONCEPT: all actions	QUERY 1 distribution %	QUERY 1 number of actions	QUERY 2 distribution %	QUERY 2 number of actions	TOTAL DISTRIBUTION QUERY 1 & 2 %	TOTAL DISTRIBUTION QUERY 1 & 2 number of actions	TOTAL NUMBER OF DIFFERENT, INDIV. SEARCH CONCEPTS %	TOTAL NUMBER OF DIFFERENT, INDIV. SEARCH CONCEPTS number	QUERY 1 %	QUERY 1 no.	QUERY 2 %	QUERY 2 no.
RECALLED FROM MEMORY	23	11	27	38	26	49	51	2o	55	6	5o	14
ORRIGINATED FROM QUERY	63	3o	51	72	54	1o2	13	5	18	2	11	3
ORRIGINATED FROM MATERIALS a.o.	15	7	22	31	2o	38	36	14	27	3	39	11
Total	1o1	48	1oo	141	1oo	189	1oo	39	1oo	11	1oo	28

See also table 4.

Fig. 8. Distribution of applied search concepts at the first action of consulting some kind of a document, and distribution of applied search concepts across all actions and all S's (below). Number of individual different search concepts analyzed (below, right).

Applied SEARCH CONCEPT: all actions	OPEN SEARCH %	OPEN SEARCH number of actions	SEMI-FIXED SEARCH %	SEMI-FIXED SEARCH number of actions	FIXED SEARCH %	FIXED SEARCH number of actions	Total distribution; all Subjects -%
RECALLED FROM MEMORY	35	18	29,5	1o	2o	21	26
ORRIGINATED FROM QUERY	4o	21	41	14	65	67	54
ORRIGINATED FROM MATERIALS a.o.	25	13	29,5	1o	15	15	2o
Total	1oo	52	1oo	34	1oo	1o3	1oo
Number of Subjects	7		5		11		From fig. 8

Fig. 9

Applied SEARCH CONCEPTS both queries: all actions	OPEN SEARCH	SEMI-FIXED SEARCH	FIXED SEARCH
RECALLED FROM MEMORY — Query 1	Education 1	Technical Schools Marks 2	Technical drawing Technical education Technical Schools 6o.7 (class in DC-system) 5 Marks
RECALLED FROM MEMORY — Query 2	Alcohol Water Temperatures Deep-freezing Hvidevarer x Hårde hvidevarer x Freezers Home-freezers Refrigerators Ice boxes 1o	Alcohol Aquavitae Freezer 3	Freezing Alcohol Spirits Beverages 4
ORRIGINATED FROM QUERY — Query 1	Technical draughtsman Marking scale 2	Technical draughtsman Marking scale 2	Technical draughtsman Marking scale 2
ORRIGINATED FROM QUERY — Query 2	Snaps Deep-freezer Freezing-point 3	Snaps Deep-freezer Freezing-point 3	Snaps Freezing-point 2
ORRIGINATED FROM MATERIALS a.o. — Query 1	Date of Govern. notice 1	Date of Govern. notice 1	Technical Schools 6o.7 2
ORRIGINATED FROM MATERIALS a.o. — Query 2	Destilled spirits Aquavitae 64.13 Aethylalcohol Etanol 5	Spirits Aethylalcohol Alcohol 3	Heating 66.83 Aquavitae Alcohol Etanol Spirit Melting-point 7
NEW SEARCH CONCEPTS: per LIBRARIAN	17 7 Librarians = 2,43	9 5 librarians = 1,8	18 11 librarians = 1,63

Table 4

After having chosen the Semi-fixed and the Open Search modes the librarians much more frequently use search concepts recalled from memory or originating from the material. This is in accordance with our expectations with regard to the consequences of the Open and Semi-fixed search modes and motives. Furthermore, the analysis of the protocols reveals that in fact Open search in a high degree implies use of search concepts recalled from the memory of the librarians.

A survey of the applied search concepts from both questions distributed in relation a) to origin b) to search mode appears in table 4. An interesting point is the frequency of "new" search concepts per S's in relation to search mode which emphasizes the earlier mentioned consequences of search modes applied. Concerning the connections between the actual search possibilities used during the information search process, table 3 shows the macro-analysis of Q1. 89

The micro analysis of the protocols shows that out of 28 examined connections 21 are explainable whereas 7 are depending on non-verbalized associations. The 21 connections can be divided as follows:

a) 7 connections are derived from a wish for information on the location of the training of the technical draughtsmen. 4 of these are dependent on information from materials and 3 on associations, i.e. a conscious formulation of lack in conceptual knowledge.

b) a relevant reference in the material constitutes 4 connections

c) "near miss" constitutes 4 connections

d) 6 connections are explainable, caused for example by the organisation of materials in libraries, wrong classification of documents related to topic and a NUN-effect, i.e. "now that I'm here I could look in it as well" effect.

From this it can be concluded that search procedures which consist of more than two actions (1 couple of applied search possibilities) are composed of both conscious assimilation and processing of information from materials (learning process), which is incorporated in the further search process, and more or less random associations and impulses from the environments. An analysis of Q2 emphasizes the same picture.

In general, terminology problems centering on synonyms, antonyms, homonyms and generic relations appear in the search process. It is a characteristic feature that these problems appear in the S's' interaction with user needs and material/tools which involve subject-specific terminology/concepts.

For example one of the reasons that the S's do not attain to sufficient results with regard to the "Danish snaps" Question (Q2) is, that the S's when reaching search possibility 1 - the physical-chemical approach fig. 3A - has difficulty in transferring everyday concepts (snaps - aquavitae - alcohol freezingpoint) into subject-specific concepts needed for continuing the search: etanol - ethylalcohol - melting point.

1 D. *Results and consequences*

The investigations into information search procedures conducted by librarians generally show that it is impossible to put the search procedures into a formalized scheme. It is impossible, although you are able to observe use and combination of specific search routines and certain search possibilities which constitute each search procedure.

However, the investigations unveil 3 different and specific search modes on which the actually performed information search procedures are depending (fig. 10)

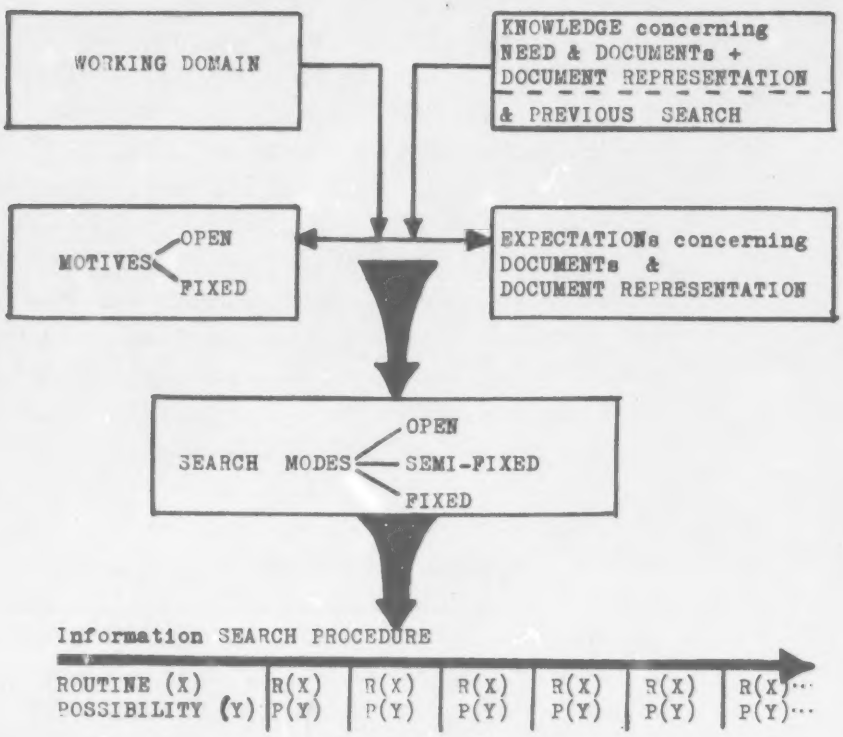
Open search mode
Semi-fixed search mode
Fixed search mode

We understand these 3 search modes as mental attitudes. Which of the 3 search modes that is employed in the actual situation does not depend on a concious choise, but is a consequence of a mental attitude formed by 4 determinating elements:

- Motives underlying the way of attacking the problem: Open search motive, to gain information useful to the librarian in the search; or Fixed search motive, to locate the document or tool which includes the answer.

This element is in interdependence with

- the expectations of documents/document representation and the mode of answer.



R(X): Certain search routines as described p. . (X) is variable.

P(Y): Search possibilities depending on the actual need - the topic. (Y) is variable.

Fig. 10. Conceptual model of the physically and mentally determining elements which constitute the individual information search procedure carried out as a search process.

These two elements are strongly influences by:

- Knowledge of the actual need (a topic), documents, document representations, and former search

and

- the librarian's working domain (lending dept., reference dept. etc.)

The interaction between these 4 elements determines which search mode the librarian uses but our investigation does not make it possible to rank the elements according to importance.

Consequently, these 4 elements constitute the actually performed search procedures. Yet, the framework of the elements is so flexible that a certain randomness is possible in the use of search routines and possibilities i.e. near miss - "now when I am here" effects a.o.

It is also important to add that, although we have stated that the librarians when they start handling an inquiry prefer action before mental consideration of the presented problem, these actions, which consist of search routines involving search possibilities, may have different objectives because of the mental attitude (search mode).

Thus, the same externally observed search routines (e.g. looking up in a tool) may be used in different ways (e.g. to gain more information or to find the answer). A typical example, see protocol pp. 56 and 57. The use of the routine changes in statement 26-27.

All these proceding steps occuring in the search process may serve to explain some of the "idea tactics" pointed out by Bates (62).

The use of the different search modes create consequences for the use of search concepts and, thus, for the chances 93

of a successful search.

The librarians implementing the Fixed search mode have a tendency to employ exactly the same concepts (primarily concepts from the query formulation) again and again throughout the main part of the search process. (P.L.(QU) fig. 4). On the contrary librarians using the Semi-fixed and the Open search mode draw upon their own conceptual knowledge (CS(L)) more frequently producing related concepts and they more rapidly obtain new related concepts to be used later on from documents and document representation. See protocol example oo. 56 and 57, statement 23-34.

This perception again involves the librarian's conceptual knowledge structure in some kind of learning process.

This means that new aspects are developed and incorporated in the search process.

Thus, it seems as if the use of semantic and episodic memory in long term memory differs according to the different modes.

In general, private experience from the episodic memory in the librarians' conceptual state of knowledge is involved, but in many cases indirectly, or with a certain degree of reservation.

Of relevance to what has been said above are the problems of everyday and scientific language. It is a general feature that the librarians do not cope with these problems in a concious (and professional) manner, although the phenomena cause difficulties.

In the information search procedures the librarians seem to allow a sort of repetitive behaviour when no immediate results of the search appear. But the reception is rarely quite the same. If it was so, the librarian should apply the same routine to the same search possibility employing

the same search concept on the same material. The repetition seems to occur at a "higher" level which means that it may be the routine which is repeated, applied to the same search possibility, but the librarian may use new material or a new search concept. Or it is a repeated search routine, but involves a new search possibility, with an identical search concept. Many times, the librarians return to a search - possibility which has failed once before. See fig. 7 and 7A.

The results summarized in this chapter obviously have some consequences.

In library education and continuing education courses knowledge of the determining elements and search modes in search modes in search processes have to be incorporated.

It is difficult to say how much the training in reference work and classification has influenced the S's' search behaviour. But one may ask if there should not be some relation between the existence of a Fixed search mode, with its lack of subject analysis and repeated use of the same few search concepts from the needformulation, and the past (and present) training in reference work. By and large this training gives priority to "little training" just as classification justifies that "a book is classed to one place in the system".

Although education for librarianship may differ from place to place the Firshein Summit investigations into the use of computerized retrieval services by public librarians seem to indicate similarities with the search patterns mentioned (63).

Training in and work with on-line information searching will surely change the search routines and thereby the librarians' search procedures. One may foresee a tendency to use a kind of Fixed search mode, because computer search invites to formalization and relatively easy dependence on few selected

combinations of commands and functions that might create a false search security similar to the manual Fixed search.

Thus, in future - with the introduction of still more advanced computer capabilities - it will be necessary to give much more considerations to the training in the mental processes underlying the on-line searching, if the quality of search results is to be preserved or enhanced.

The cognitive processes and elements involved in the information search processes are very important devices in the training in methods of information retrieval.

2. THE USER'S SEPARATE SEARCH

In general it can be stated that the result of the user's search is dependent on the following conditions:

- whether the user understands the connection between the catalogue, the index to the subject catalogue and the organisation of documents on shelves (Dr→D, fig. 4)
- whether the user understands, knows or recognizes the organisation structure of documents
- whether there is or may be created accordance between the user's concepts and the subject entries in documents and tools.

Thus, it is a question and a problem concerning the match between the user's conceptual knowledge structure (and the anomalous state of knowledge) and the knowledge structures implemented in the documents/document representations.

Danish catalogue use investigations (64, 65) show that 10% of users in public libraries employ the catalogue. Only one half of these are able to combine the catalogue, subject index and the organisation of documents on shelves. This stresses the intermediary's important role.

Concerning the general structure of the organisation of documents (in Denmark the DK5-system which is a modified/ simplified derivation of the Dewey system) the analysis of the protocols shows that non-experienced library users involuntary try to establish an alfabetical order between the signs. Not finding this order they completely give up to establish a general order. Instead they make a random search to find a sign containing the concept by which they have labelled their need. Otherwise, they try to find a sign labeling of a subject to which they may adapt their need.

If the topic for example may be characterized as ADP, an intensive search for this sign will take place and other possibilities be excluded. If the user need is not formulated in a superior generic term - for example "raising vegetables" - it is easy for the user to adapt the need to a presented sign/topic for example "hobby", because it is a hobby for the user. The signs are interpreted as an advertisement board of the contents of the shelves, probably just as guiding as misguiding.

When the user descends to more limited units of the system, for example a main class in the system, they are facing other kinds of problems.

The users identify the topic of the documents by looking at the titles whereas librarians identify by using a combination of titles and class notations. An important problem faced by the users is the appearence of the different (knowledge) structures which are built into in the system. An example may illustrate this:

A user is seeking information about "navigation instruments for aeroplanes"
- he ends up in DK-class 62; electronics (Fig. 11):

"this is the shelf with radio engineering /2/ but whether it should be here" "/5/ then there is a title about elementary television engineering and /2/ohh there is something about aeroplanes here /2/there is a whole shelf with aeroplanes" (the shelf concerning war aeroplanes, class 62.629) "it's evidently only what /1/ the aeroplane /1/ looks like and how it flies", "Hawker Hurricane, that's a special aeroplane /9/ and then we come down to the shelf underneath and it is motor wehicles (class 62.72) in any case it can't be there, it has to be here under aeroplanes /6/ so on this shelf I don't think I can expect to find anything". /9/ means 9 sec. pause.

62	Mechanical Engineering Heating. Electronical engineering
62.1	Heating. Lightening. Pneumatic technology Low temperature technology
62.2	Mechanical engineering
- 62.3	Electrical engineering. Electronics
62.4	Fans. Blowers. Pumps
62.5	Tools and fabricating equipment
62.6	Military engineering
62.628	Ships of war. Nautical engineering
- 62.629	Military aircrafts
62.7	Transportation engineering
- 62.72	Land transportation
62.8	Nautical engineering
62.9	Aerospace engineering
62.95	Aircrafts

Fig. 11. Example of knowledge structure of DC-System

It is obvious that the user misses the general class concerning aeroplanes (class 62.9), because he firstly meets class 62.629 concerning military engineering (including air force), subsequently class 62.7 the main class for means of

conveyance, including 62.722 motor vehicles. The user does not descend further in the system, and when he has been in one class concerning aeroplanes how should he imagine that there is one more in 62.9?

Thus, the example illustrates the complications which arise when the knowledge structures, which are implemented in the system, and the user's knowledge structures are different.

When concluding we presume that no logic or helpful order is immediate by appearing to the user within the organisation of the documents. The results of an attempt to cope with this problem by means of signs will turn out differently, depending on which user groups and user needs one tries to comply with.

3. THE NEGOTIATION PROCESS BETWEEN USER AND LIBRARIAN

The sequential and interpersonal analysis

Mentioned under analysis methodology shows the following (general) characteristics:

- From the beginning of the communication the librarian's status or communication position is regarded to be very strong by both parts, caused by her role representing the institution and the fact that the user is regarded as a sort of "guest".

- If the librarian in her opinion has an established state of knowledge concerning the topic and the need situation formulated by the user, she tends to lead and administer the dialogue. Thus, the user turns to a more passive position.

- When the librarian admits lack in her conceptual knowledge and has difficulties in establishing a knowledge of the topic/need situation the position

between the partners is much more "symmetrical". When the user from the beginning shows up to be the topic "expert" and the librarian appears to be the "expert" concerning search, the user has much more the position of leading the dialogue, and it is the librarian who makes insertions trying to obtain information. Furthermore, the "symmetrical" communication situation may be established because of a listening attitude of the librarian and an equal way of treating the user throughout the dialogue.

Both the librarian's belief in knowing very much about the problem and her position may create situations which have negative effects, if the user wants to correct the librarian's picture of the need/need situation.

In trying to correct this picture and/or to assume the leading position the user shows meta-communicative behaviour such as use of "eehh" and insertions which often lead to speaking both at once. The user's weak position may be characterized by indirect questions to the librarian ("one may perhaps regard...?") and other meta-patterns.

The "eehh", as well as pauses, may also be used by the leader of the dialogue to maintain this position:

	user:	librarian: (in leading position)
1		eehh but eehh .. shall we try to
2		stick to the point . it was obvioys-
3	in '39----------	-ly in '39 . it went on, yeah!
4	it is especially eehh----------	(mumbling: may I?) (72)
5	I think it was in May	
6		(mumbling)
7	that it was really going on	
8		yeaa .. a eehh
9	there was a correspondance . I	

	user:	librarian:
10	think . heard something about ..	
11	if I could get it improved by	
12	some other books	
13		yeaa . ə . so in (73) "Germany and
14		Sovjet had found each
15		other and ... (he continued to read)

(72): looks for a book on the shelf and takes it down
(73): looks in it . : 1 sec. pause
(from the protocol concerning nonaggression pact ...)

(insertation line 3 - 12)

Besides using pauses as an instrument to maintain a leading position pauses within the dialogue are used in the thinking process to reorganize knowledge and data; line 1 - 3 above.

Closed questions appear in different shapes and are used in different ways. Closed questions are questions to which the answers first of all must be "yes" or "no". If the user wants to contextualize his "yes" or "no" he will have to pass or break the formal frames of the closed question, (see ex. 7 ..., line 15 - 19).

The protocols show several examples of closed questions:

	librarian:	user:
example 1. (Boole)	"Is he old - this chap?"	"yes - he is from 1815"
example 2. (Boole)	"Have you looked over here in EDP?"	"yes, I just passed by"

A special kind of closed questions we define as Leading closed questions, which means that the closed question contains formulations which indicates expectations as to the user's answer. Example: (see also example 7, line 24 - 25 + 33 - 34):

example 3. (Boole) "Consequently, more mathematical than philosophical?"

"Muhh - yeaaa"

example 4. (Boole) "But where, where have you .ehhh met that before?"

"Yeaa you see . ehh .. I . ehh once someone told me ..... cont.

The analysis at the substantial level

We have confirmed our analysis mainly to the "Non-agression pact" and the "Boolean algebra" protocols, because different technical and topical reasons make the other protocols more or less unusable as a whole at this analysis level. Furthermore, the two chosen protocols display different characteristics.

Thus, we are not dealing with statistical samples, but we are trying to carry out a qualitative analysis.

In the analysis of the substantial level we have focused on the match between different knowledge structures, and we have tried to look at the means by which the librarian tries to build up a picture of the need/need situation.

What we have written about the open and closed questions above are more general considerations, and we find it necessary to investigate more closely the context in which the different types of questions are used, and the function of the questions at the moment they are posed.

Also, we have to look at the user need formulation, both at the start and throughout the negotiation process.

The "Non-agression pact" negotiation may be characterized as mainly asymmetrical, with the (lending) librarian as administer of the dialog possessing a rather wide knowledge of the topic which is within the field of humanities. The user himself has searched on the shelves, but has stopped in "History in general" (class 90) because the following notation - 91 - showed up to be the "History of culture". From the recording of the user's own search we know - but the librarian does not - that his real need is:

> "Non-tendentious literature about the German-Sovjet non-aggression pact of 1939, in the form of sources, correspondences and the text of the pact, with special regard to clarifying from which the initiative originated".

The "Boolean algebra" negotiation is much more symmetrical with the user as administer of dialog throughout main parts of the interaction. The user has a strong knowledge of the topic, while the (lending) librarian possesses a limited one. The topic is within the field of applied science, i.e. electronics. The user has searched through philosophy, Edp and mathematics on the shelves but stops, because no relevant information appears in these classes. His real need is:

> "Literature with regard to identities of (the algebraic doctrines of) Boole in a form suitable for application in relation to design and repair of circuits in computers"

Taylor's law - the label effect

According to the steps of Taylor (15) - i.e. the representation and development, in the user's mind of the information need towards the external representation of it - the 3rd and final internal step in the user's mind is the 'Formalized need" (see page 10).

This step is revealed in all protocols concerning the user's own search as well as step 4 - "The compromised need". The thinking aloud-technique does not explicit the need situation itself nor stage 1 or 2 to be analysed because of the verbalization of thought patterns.

There is no doubt that the interaction with the files and shelves helps the user to describe his area of information need to himself in concrete terms. The important step is the 4th, which Taylor describes: "The compromised question - the representation of the need - is the information specialist's business, the representation of the inquirer's need within the constraints of the system and its files. The skill of the reference librarian is to work with the inquirer back to the formalized need (step 3), possible even to the conscious need (step 2) and then to translate these needs into a useful search strategy." According to Taylor, the system and files include the intermediary.

The importance of the nature of the user's first need formulation to the librarian is obvious. It is at this starting point the next part of the interaction regarding the subject area of the query, expectations and package of information is formed and on which it depends.

In the protocols we have found that the users in the important first formulation of their need to the librarian compromise the subject description of the real need in terms of a label. The label consists of one or some concepts, out of the context, which forms the real, formalized need. Even when the users in the phase of thinking aloud during their own search have specified statements clearly in mind, this label effect appears. We will show 2 examples:

A: The first formulation of the "pact" need, see ex. 7, line 1 - 9.

B: The first formulation of the "Boolean" need

"Yes, I am looking for ehh . Boolean algebra . and . or logic algebra and ehh I have now been in"

Insertation: Will you please repeat that?

This means that the presentation of the need to the intermediary, concerning the subject area involved, immediately is more or less outside the context of which the user might search for in reality.

The problem to the librarian is to be aware of this possibility of misguidance (ambiguity). The rather few concepts which constitute the label of the not yet expressed need describe subject areas or categories, which may always be related to several, different topic areas or aspects.

In fact, this emphazises the importance of the quality of the negotiation which has to follow up the first user statements, as quoted from Taylor above. The role of the librarian is to find the right context by making the user expand and specify the statements by application of a conscious and deliberately structured dialog.

Reformulations of user need

The user's formulation of the need may, as a consequence of a continous dialigue, be repeated and reformulated, either the librarian tries to structure the dialogue or not. An example of the reformulation/repetition of the user need formulation is given below:

example: 1st need formulation: "yes, I am looking for ehh . Boolean algebra . and . or logic algebra eeh I have now been ....."
(line 1 - 3) ..... in philosophy"

2nd need formulation: "there is "Elementary algebra" and
(line 52 - 58) "koblingsalgebra (danish expression)

(librarian: . aha, yes)
and ehh it is as I mentioned not exactly this I'm looking for, koblingsalgebra ... what I/ what I want is, that is his . quite exact doctrines"
(librarian: that's what you want?)
yes"

3rd need formulation: (line 95 -99)
(the user has found something in a book on mathematics)
"... then I find ... that they are written in . in a little different way than we normally use it, within the field of EDP-technique
(librarian: mmmmm)
more mathematically orientated than it is . logic, I mean within the field of 'ciffer'technique". (Ciffer technique = danish translation of digital technique)

4th need formulation: (line 257 - 265)
"ehh, what shall I say, I have, I have partly found him here under mathematics "General concepts within logic and algebra" (book title)
(librarian: yes)
"but ehh, what should I say, it's not in that form I can use it within the field of digital technique"

5th need formulation: (line 297 - 305)
"now we have got his identities, and here we have his laws . but they, they are still not just so ....
(cut, 5 lines)
I mean, it has to be more technical, so . as you say, was it class 62?"

It is obvious, that the user clarifies his need in relation to

different materials, because it's difficult for him to express the need in exact terms to the librarian who is a non-expert in the area. The different need formulations and elaborations are in this case adopted by the user in his attempt to include more contexts than the 1st need formulation.

If the librarian searches only on the basis of the label and doesn't ask structured questions immediately, she is bound to follow wrong trails in many situations.

Thus, the function of the questions as an instrument in the negotiation process becomes essential.

Function of questions

The function of both kinds of closed questions seems to be strongly related to and depending on the present state of knowledge of the librarian concerning the topic.

If the librarian trusts her state of knowledge of the topic or if her knowledge is a fact both kinds of questions are generally used to confirm and to delimit the librarian's picture of the need/topic and search possibilities.

This function of the closed questions is appropriate from that point in the negotiation when the librarians' understanding of the need corresponds with the real user need.

		Librarian:	User:
Ex. 7	1		"I am interested in ehh . in
(The Non-	2		ehh the German-Soviet Non-
aggression	3		aggression pact in '39"
pact)	4	"Yes"	
	5		and I would like to see
	6		if you have something more
	7		detailed than this [stands

8		with a book] .. about the Non-
9		aggression pact"
10	"Yes, I think so	
11	. I think we	
12	may find some-	
13	thing . ehmmm	
14	"must it be in Danish	
15	or may it be in English?"	
16		"It may be"
17	"possibly German?" ----------	"It just has to
18		it just has to . ehhh
19		. so . ehh - inform about
20		.. how it . it happened
21		. and and and who
22		opposed whom and
23	"Yeaa"	so
24	" . so, you want it more	
25	detailed?"	
26	"Ehmm"	"Yes"
27		"I want
28	"Perhaps you would	that"
29	also like to have the	
30	text itself?"	
31		"Yes"
32	in in the pact? ..."	"It . yes"
33	"But ehh . consequently it	
34	may be in English or German?"	
35		"Yes - that doesn't matter
36		in a way"

In an interpersonal situation with the librarian as the administer of the dialog the closed questions may support the "guest"-position of the user. Consequently it is difficult for the user to correct or deepen the topic/need by insertions, if the librarian is on a topic trail, which does not in fact correspond with the conception of the user (example page 91).

If the librarian admits to possess a rather limited knowledge of topic and user situation, the function of both kinds of closed questions tends to be an instrument for extending the librarian's limited picture of the need. The leading closed questions are most frequently used to confirm different pieces of information, which the librarian has caught throughout the negotiation process and which she tries to combine to a whole. Esample 3 and 4.

Most of the time normal closed questions are used to trace pieces of new information, example 1 and 2. In negotiation situations in which the librarian admits lack of knowledge, the time that elapses from the start of communication until the picture of the real need is established in the mind of the librarian, is long. Furthermore, if the communication situation is more "symmetrical" the closed questions do not tend to consolidate a user "guest"-role. In such situations it does not seem difficult for the user to break the formal frames of the closed questions. Hence, the normal closed questions tend to be signals in the feed back operation which in these situations may open up for a possibility for the user to break the frame and contextualize:

	Librarian:	User:
Ex. 8 (Boole)	[Standing with a book] "Is this . is it Boole this?"	"Yes, that"
		"It's his laws . but his ehhh . his dogma/doctrins are not here ."
		"ehh what shall I say, his they are called identities . then I have looked over here ."

The function of the open questions are more difficult to circumscribe, because they rather seldom occur in the

protocols. Thus, our comments on this type of questions have the character of suggestion, based on the limited experience from the protocols. Anyway, the function seems to be strongly related to and depending on the present state of knowledge of the librarian.

We have indications that show that in situations where the librarians' state of knowledge of the topic is weak, the consequence of the open questions may be, that the answers bring out data or concepts from the user which the librarian is unable to utilize as information in the immediate situation. One may say that the librarian at the moment is unable to control the succession of relevant data and to perceive those, which many times later in the negotiation and search process, from a theoretical point of view, turn up to be useful.

Open questions are not revealed in the dialogues in which the librarian has or believe to possess a strong state of knowledge of the topic.

In few cases, we have indications which suggest, that the librarian prefers to put closed questions where open questions could be used. This relates to the above mentioned question concerning control of the data supplied by the user. Instead of asking: "In what connection did you come across that phenomenon?" (open question) the librarian may present the following closed question: "did you come across this in a book of philosophy?". This question contains metacommunication indicating which type of answer she wants (i.e. could be useful at the present state of the negotiation): she wants an answer which partly indicates the need situation, and partly in a rather concrete manner relates the need to some kind of superior topic.

Furthermore, we can turn to the user point of view in this situation. If the librarian's state of knowledge of the topic is weak, and she uses open questions in the start of the negotiation, it may be difficult to answer in a useful manner. He has either to suggest, that the librarian knows nearly as

much as he does, or he can be uncertain whether the librarian is able to perceive/understand his answer or not. It is up to the user to decide at which level he will answer, because he has not got any clues from the librarian. This may in general cause some uncertainty. Of course, this is different later in the search, where the librarian and user have worked with the problem together.

In the later search situation, the open questions are used when the topic area to which the answer will be relat[illegible] is limited.

Hence, we suggest that experience regarding the difficulties of perceiving data may indicate an explanation of the practitioners' rare use of open questions which has also been reported and considered by Mary Jo Lynch (66) and recently by Barnes (67).

Another phenomenon observed in the protocols is the librarians' practice of putting more than one question to the user at the same time.

Ex. 9 (Boole)

Librarian:	User:
"But where . where have you	
. ehhm where have you	
encountered that before?	
	(eeh, yes, see that..)
Was it in a book on philosophy?	
or in which connexion have you	
come across that?	(yes you understand...)

This kind of questioning may - whether the questions are relevant or not - confuse the user. He has to choose between different answers and levels of answers.

From the librarians point of view this manner of questioning has a complementary effect, deepening and exemplifying the

mode of answer, using for instance closed questions to warn the user against delivering too much context in his answer or to tell him to keep the same categorization level as indicated in the question.

Match of the knowledge structures

The protocols show examples of the constant attempts to transfer concepts from both user and librarian in the negotiation. On page 5 (42 A - 42 B) we have shown different formulations of a need. Examinations show that these different expressions of the need do not correspond to the librarian's knowledge structures in terms of the whole context. However, single concepts and topic relations are perceived and combined by the librarian to a picture of the real need. This construction takes place - piece by piece - rather slowly concurrently with concepts from the user hitting corresponding/identical concepts in the librarian's state of knowledge. Concepts which cannot be recognized or structured appropriately are not perceived or stored by the librarian.

The pieces of the contexts, which in fact are perceived, may be placed at several levels of categorization, either situational or categorical, depending on the shape of the knowledge structures of the receiver of the information.

In bringing the pieces together to a picture which as a whole matches with the real need the librarian has to combine new received concepts with already perceived and stored concepts and topic relations. This process, which may be regarded as a learning process takes its time. Below we will show an example of the use of different knowledge structures, the process of combination and matching: In trying to transfer his need the user starts off with a categorical presentation of his need relating Boolean algebra to philosophy/logic and mathematics. This is in accordance with his expectation to find a universal way of dividing concepts in the library and the

librarian's way of thinking. When this approach does not succeed in relation to the librarian and system he turns to explain his working domain in specific categorical relations:

	User:	Librarian:
100		"and your field is EDP then?"
	"yes"	
		"that is your field?"
	"yes"	
		"yes"
105	"Thus, the ciffer technique	
	or	"ciffer"
	digital technique as	
	it is also called"	"oh
109		. ohh digital
(protocol lines)	.	.
	.	.

The librarian catches a concept (digital) but it does not immediately change the search situation.

A little later the user turns to explain his need in terms of situational categorization at a superiour level by involving his working situation and the role of Boole:

	User:	Librarian:
	.	.
	.	.
	.	.
	.	.
201		".. then when you say one may have that .. your field is EDP . no?
	"yes"	and
205		and here he comes
	"yes"	into the picture then?"

"you" "with"

"you ehmm, see when you
design a ehh circuit for "yes"
for . ehm . for EDP,
that is data - ehh
- machines and such things
ehh computers . that's where
you use his doctrines and
laws when you design"

. .. "have you looked over here
. at EDP?" .
. .
. .
. .
. .

In this case the user's situational categorization is in accordance with the structure of the system and the documents in the field. However, the librarian relates it to EDP-theory material which reveals the doctrines but in a wrong shape (class. 19.6) (not applicable in circuit design).

Until this point in the search and negotiation, it has not been possible for the librarian to combine the perceived concepts to relevant information in relation to a search strategy. From the earlier user statements - containing the synonyms "digital technique"/"ciffer technique" - the librarian has recognized "digital technique", and on the basis of the former search experience she is now using the concept as a clue to switch to "electronics".

User: Librarian:

. .
. .
. .
. .

[standing at EDP - 19.6] "Then eh and
"Here we have "Gyldendals

EDB-leksikon" . maybe he
he is mentioned there"

"Maybe yes . we may try to see .
but otherwise I think we
shall ... move to

" . to mathematics"

to mathematics or . although
when, when you say digital
eyh . then I think of something
to do with electronics

"yes, but

more than . obviously, if it
mm . I would not look
up in mathematics for
if . I would walk down
to electronics."

. "yes"
"if mm . he has to
be both places"

The librarian's accumulation of previous experience gained through the negotiation process leads to a kind of "jump" in the cognition. This illustrates a categorial classification within the librarian's state of knowledge (digital→electronics) followed by a trigging of a previous established relation between a category and the classification system within the state of knowledge of documents and document-representations - fig. 4 . (semantic memory) (electronics→class 62).

It is at this point that the user, aided by the librarian, matches his real need and knowledge structure with the structure of documents and their contents - because these structures correspond.

The match could perhaps have happened earlier if this clue had been recognized in the beginning. The clue appears in connection with questions concerning user need and situation - the user's working field. This kind of questions seems

important as the examples above indicate. Until they are posed, the librarian relies on the original need formulation and she has the possibility to relate the topic to philosophy/logic (class 11) or mathematics (class 51). When the need situation of the user is involved he shows up to work within the field of electronics, in which Boolean algebra is applied in designing of circuits. The Boolean algebra is involved in an applicational aspect, and two new search possibilities turn up, Edp-theory (class 19.6) and electronics (class 62).

Another clue could have been "designing of ... computers" (class 62), also stated by the user because of a need-situation-question.

Hence, it seems that in case the user and librarian do not know about each others background it might be fruitful for the librarian to make inquiries concerning the user need situation which thus will be in shape of an open question. This information elaborates the librarians picture of the user need and broadens the framework of the query.

In many cases the starting point of the negotiation is the user's formulation of a problem which he himself or the librarian tries to relate to different superior topic and concepts - for example in relation to the classification system. The advantage of posing questions to the need situation is the widening of the context, and hereby to obtain relations to some kind of process or working situation which constitute new aspects or reformulate the topic (often situational categorization).

As mentioned many concepts formulated by the users are not perceived/recognized by the librarian. Thus, they just seem to disappear unless the user repeats them. As a general feature in the protocols, this phenomenon depends primarily on the knowledge structures of the librarian.

One routine seems to be important in this case: To write down some of the concepts mentioned by the user, even if they are not recognized by the librarian.

In all our investigations nobody took notes.

Thinking of the LTM and STM model, fig. 2, it is obvious that the filter and the STM are involved. The difficult task is when your knowledge of a topic is weak - again and again to recall relevant concepts from memory (LTM) and to recognize user concepts linked to new information - items which have to be grasped.We suppose that in this case filter and STM may be overloaded with data which change fast and consequently create a barrier. Notes and methodic work with search profiles may extend STM and hereby later contribute relevant concepts and topic relations.

It has not been possible to make the obvious comparison between the results of S's' separate search procedures and the results of the negotiation processes because of the paucity of comparable material. However, we have indications that lead us to suggest that there exists a correlation between open search and "symmetrical" negotiation.The user's and the librarian's "symmetrical" position is characterized by a situation where the user - on an equal footing with documents and tools - acts as a resource by providing answers and insertions that supply and adjusts information to be received and adapted by the librarian according to the real need. In the above position the librarian seems to have a motive to gain more information relevant to the comprehension of the need or parts of it, before the final step of attacking the search problem is implemented.

In addition, we suggest a correlation between the "asymmetrical" negotiation, with the librarian as leader of the dialogue, and semi-fixed search. Characteristic to this position is the librarian's immediate searching for an answer to satisfy the user need as identified by her (whether wrong or right). User

insertions may momentarily lead to some kind of open search.

In our rather few negotiation experiments we have not been able to observe fixed search procedures. The absence of fixed search may be due to the user's influence - even in an "asymmetrical" position. Fixed search may be expected to occur when the user is separated from the librarian during the search process or when the user deliberately maintains a silent attitude. Such patterns have not occured in our negotiation experiments.

VII CONCLUDING REMARKS AND CONSEQUENCES

The study has been very broad in scope, examining appropriate experimental settings, methods of analysing verbal protocols and ways of linking observations to current theories of cognitive processes in a broad range of scientific fields. This has been carried out in relation to investigations of the search procedures of librarians and users and in relation to the negotiation processes.

To us it seems that an underestimation or neglect of the intermediary's role hitherto has been a barrier to the recognition of information science, especially the subfield of information transfer, which appears to be a highly complex problem area, as indicated, is concerned with and depends on processes of a fundamental cognitive nature.

The application of the thinking aloud technique has been fruitful for the isolation of mental processes and mechanisms in various search procedures in libraries, and together with observations of and discussions with the S's' this technique has proved a valuable instrument in the investigation of the search and negotiation processes. The S's' have found it natural to think aloud during parts of the searches and they have added valuable information in the subsequent "self-confrontation". The technique is clearly obtrusive, and

there is a large proportion of pauses, indicating a considerable loss of thought processes. The user-librarian negotiations are deliberately made long compared with unobtrusive observations in libraries. Moreover, the experimental setting has allowed us to get rather close to the user need and the user need situation, bearing the obtrusiveness of the method in mind.

The developed and applied analysis methods have proved usable, although they in general need much more elaboration. We have felt a need for a method to uncover, compare and follow the changes in different knowledge structures and states of knowledge.

We consider that the theoretical developments in information science should be accompanied by a development of appropriate experimental designs and methods of analysis within the field. Hopefully, this methodological refinement may not only lead to an improved theoretical foundation of the discipline but also result in an improvement of the practical user services offered within the library and I & D sector.

A crucial point in the information transfer process is the match between different knowledge structures, i.e. that of the user, the librarian, and the information system. This relates to the main findings which stress the importance of a conscious attention to the mental procedures of the individuals involved in the information transfer process.

The education area of librarianship appears as the most obvious field for application of the findings of the present project and study. So far the results achieved have been used as a basis for modifying and enriching teaching materials and methods.

Especially the design of reference exercises, negotiation exercises, the teacher aids in solving search problems and the possibility of estimating the degree of difficulty of

search tasks have been improved by the insights gained from this study.

Finally, the study may have implications for the design of systems, although we have not paid very much attention to this aspect in the present report. These implications seem most obvious in the field of application of computers to the information transfer processes.

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